A SOCIAL APPRAISAL OF THE ENVIRONMENTAL IMPACTS OF RETURNABLE AND NON-RETURNABLE CONTAINERS FOR CARBONATED BEVERAGES

by

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INTRODUCTION

CHAPTER I.

INTRODUCTION

1.1 Rationale for studying the beverage container issue

There is a concern over the increasing social costs caused by the rising quantities of litter and solid waste generated in most developed countries [see Organisation for Economic Cooperation and Development (OECD) (1976, 1978)]. Beverage containers have been identified as a specific product category for which there has been an increasing use of non-returnable instead of returnable containers in almost all countries [see OECD (1978)]. It is considered that these recent trends have contributed to the rising social costs of litter and solid waste. Primarily on account of this concern, legislation affecting carbonated beverage containers has been passed in a number of countries(1). In relation to the U.K., the Waste Management Advisory Council (WMAC) recently prepared a report on this subject [WMAC (1980)]. The issue is being reviewed by the U.K. government and also by the EEC [see House of Lords European Communities Committee (1982)].

Tables 1.1 and 1.2 show that the market share and trippage(2) of the returnable bottle in the U.K. market for carbonated beverages are lower than the market shares and

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(1) Appendix I presents an overview of the legislation, directives and policies concerning carbonated beverage containers that have been implemented in various countries.

(2) The term trippage is the (average) number of times a returnable bottle is used for delivering beverages to the Consumer.

Table 1.1

The market shares of the containers for beer and carbonated soft drinks in various countries

Country	(Year)	Market share[1] of container: Returnable Bottle	Non-returnable Bottles (glass and plastic)	Non-returnable Cans
U.K.	(1977)	60.0%(38%)[2]	11.0%(17%)[2]	29.0%(45%)[2]
Sweden	(1975)	65.1%(50%)[2]	8.5%(9%)[2]	27.4%(41%)[2]
France	(1976)	76.6%(71%)[2]	23.4%(29%)[2]	
France	(1975)	80.8%	19.0%	0.2%
Germany	(1976)	91.5%	4.2%	4.3%
Netherlands	(1975)	96.6%	1.6%	1.8%
Denmark	(1975)	97.5%	0.3%	2.2%
Switzerland	(1975)	97.6%	2.2%	0.2%

Source: OECD (1978)
PLM (1976)
Metal Box Market Research Division
Data supplied by Peat Marwick and Mitchell Partners, Paris.

(1) The market shares above are in terms of percentages of the volume of beverage sales.

(2) The figures in brackets refer to the market shares for 'off' premise sales of beer and carbonated soft drinks. The other figures in the table refer to the total 'on' and 'off' premise market. The 'off' premise market comprises beverage sales, principally from 'off' licences and other retail outlets, for consumption away from the place of purchase. The 'on' premise market comprises sales in pubs and door-to-door deliveries.

Table 1.2 The Trippage Rates Achieved in Various Countries

COUNTRY	(Year)	Total Trippage (T_t)(1) Beer + Cider	Total Trippage (T_t)(1) Soft Drinks	Off Premise Consumer Trippage (T_c)(2) Beer	Off Premise Consumer Trippage (T_c)(2) Cider	Off Premise Consumer Trippage (T_c)(2) Soft Drinks
U.K.	(1974)	13	9	4	7	5
CANADA						
Ontario	(1975)	33	13	25		
Quebec	(1975)	33				
FRANCE	(1976)	22	15	41		13
SWITZERLAND	(1975)	60-80	20-70			
GERMANY	(1975)	25	9			
SWEDEN	(1972)	17			17	
FINLAND	(1975)	30				
NORWAY	(1977)	35				
DENMARK	(1974)	31				

Source: OECD (1978)
Ontario Waste Management Advisory Board (1976)
Peaker (1975)
Applied Decisions Systems (1974)
PLM (1974, 1975, 1976)

(1) The total trippage rate (T_t) is the average number of times a bottle is used for filling and delivering beverages. It can be derived from the following formula:

$$T_t = \frac{1}{1-(ARR-APB)}$$

where ARR = The proportion of bottles that are returned by consumers

APB = The proportion of bottles that are broken at the bottling plant, retail outlet or in transit.

The total trippage rates (T_t) given in the table above relate to the total 'on' and 'off' premise market.

(2) The consumer 'off' premise trippage rate (T_c) is the average number of times that a bottle is returned by consumers to the retail outlets. This is derived as follows:

$$T_c = \frac{1}{1-ARR}$$

Table 1.3

Trends in market shares in the U.K. market for beer, cider and carbonated soft drinks(1)

YEAR	Container Type RETURNABLE Bottle	NON-RETURNABLE Bottle	NON-RETURNABLE Cans
1970	84.0%	5.0%	11.0%
1972	76.0%	8.0%	16.0%
1974	70.0%	9.0%	21.0%
1976	61.0%	10.0%	29.0%
1978	53.5%	11.5%	35.0%
1980[E]	47.0%	12.0%	41.0%

Source: Metal Box Market Research Division

E = Forecast

(1) The market shares given in Table 3 above are in terms of percentages of unit fillings of beverage sales.

Table 1.4

Trends in trippage rates(T_t) in the U.K. beer, cider and carbonated soft drinks markets

YEAR	BEER AND CIDER	CARBONATED SOFT DRINKS
1930	?	20
1972	18	10
1973	15	10
1974	13	9

Source: Glass Manufacturers Federation (1973)

Data supplied by R. Cook, United Glass Containers Ltd.

trippages that are currently achieved in most other countries. Moreover, the market shares and trippage of the returnable in the U.K. have been declining in recent years (see tables 1.3 and 1.4). These trends are forecast to continue in the future and such a continuation could place in jeopardy the future of the returnable system for beverages in the U.K. This current situation raises the question of why the trippage and market share of the returnable bottle are so low in the U.K. and whether consideration should be given to measures to prevent any further decline in the returnable's position and to increase the trippage and market share of the returnable bottle. In countries where beverage container legislation has been implemented (e.g., Oregon in the USA and Sweden), such previously dominant trends away from returnables were stabilised and in fact reversed.

This experience prompted Friends of the Earth to advocate that mandatory deposit legislation, similar to that passed in Oregon, should be implemented in the U.K.(3) [Cawdell (1980)]. Similar beverage container policy measures have also been proposed in a number of Private Members' bills. While the WMAC recommended that no specific action should be taken by the government but that the beverage industry should itself undertake 'voluntary' measures to increase recycling and improve the position of the returnable. The industrial groups have opposed the implementation in this country of any legislation, such as

(3) These initiatives concerning beverage containers received a wide coverage in the Press [e.g., see New Scientist (1980), Financial Times (1980), Guardian (1980), Times (1980), Observer (1980)].

the Oregon bottle bill measures, and have argued that such overseas' experience is not applicable to the particular circumstances in the U.K. beverage market.

1.2 The objectives of this thesis

This thesis sets out to perform an economic analyis of the environmental impacts of carbonated beverage containers in the particular context of the U.K. situation. Specifically, the thesis has three principal objectives:

(I) On the basis of economic theory concerning market failure, to draw up a set of criteria for the government to consider intervening in the beverage container markets.

(II) On the basis of the theory and practice regarding the economic techniques and the various other approaches for the evaluation of environmental impacts, to develop a general methodology for the assessment of environmental impacts and to apply this general methodology to a specific market failure relating to the beverage container issue by performing an evaluation of the environmental impacts of the alternative returnable and non-returnable containers for carbonated beverages.

(III) To study the trippage of the returnable bottle. In particular, to examine why some U.K. consumers do not return bottles and how the return rate and trippage of returnables could be most effectively raised.

1.3 The scope of this thesis

This thesis comprises two main parts:-

(I) An analysis of the external costs of the alternative container systems for carbonated beverages. This comprises an investigation of the following areas:-

(i) the disposal of beverage containers in domestic solid waste;

(ii) the littering of beverage containers;

(iii) air and water pollution and industrial solid wastes generated at the process stages involved in the beverage container systems;

(iv) public health and hygiene impacts arising from the presence of any contaminants in the packaged beverage and from the storage of the beverage containers at the retail outlets;

(v) the urban traffic congestion caused by the distribution of the beverage containers to the retail outlets.

(II) A study of the trippage of the returnable bottle.

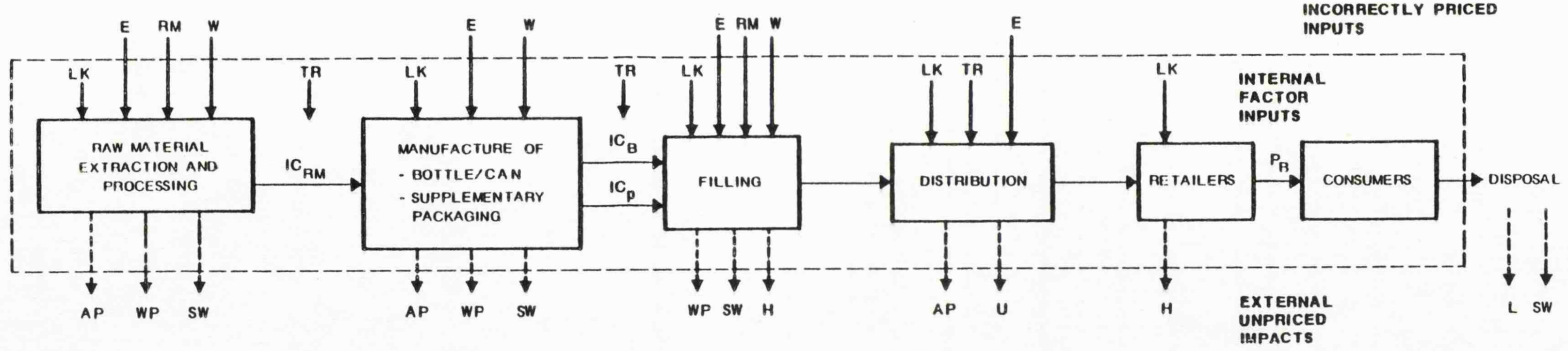
Figure 1.1 shows the process stages in the returnable and non-returnable beverage container systems that are covered in this study. This figure highlights that the returnable system is essentially different from the non-returnable system on account of the re-use loop in the returnable system. The study of the trippage of the returnable bottle examines the effectiveness with which this return and re-use loop currently operates. Other important differences between the returnable and non-returnable systems derive from the different types and quantities of materials required at the various process stages. The analysis of the external costs covers the external unpriced impacts appearing below the dashed line in Figure 1.1, which highlights the major process stages from which these external impacts, listed above, are generated.

The thesis covers the principal containers that are currently used for 'off' premise sales of beer, cider and carbonated soft drinks (i.e., returnable glass bottles,

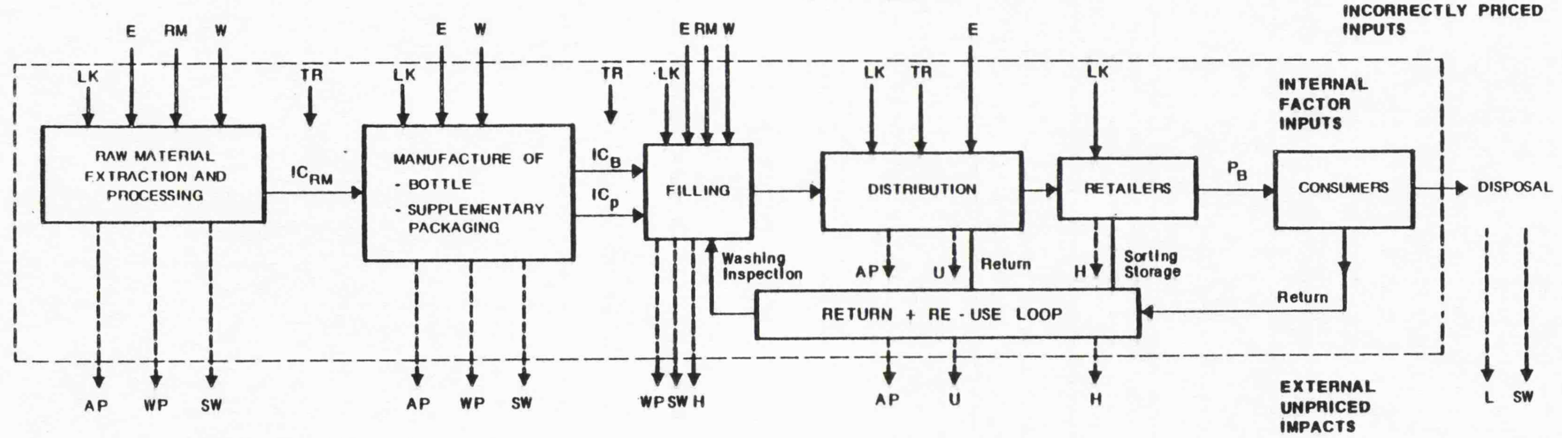
Figure 1.1

PROCESS STAGES IN THE RETURNABLE AND NON-RETURNABLE CONTAINER SYSTEMS FOR CARBONATED BEVERAGES

A. Non-Returnable Systems



B. Returnable Systems



Where Internal Input Categories

LK = Labour, capital, land (e.g. Space) and other factor inputs.
E = Energy.
RM = Raw materials.
W = Water.
TR = Transportation to next process stage.
IC_{RM} = (Internal) Cost or price of processed raw materials.
IC_B = (Internal) Cost or price of container.
IC_p = (Internal) Cost or price of supplementary packaging.
P_B = Price of packaged beverage to the consumer.

External Output Categories

AP = Air pollution emissions.
WP = Water pollution emissions.
SW = Solid wastes.
L = Litter.
U = Urban traffic congestion.
H = Hygiene impacts of any contaminants in the packaged beverage and from the storage of the beverage containers at the retail outlets.

non-returnable glass bottles, aluminium and bimetallic cans[(4)]. This scope for the study was selected for four main reasons.

First, it is these containers for carbonated beverage containers that are the main focus of the current concern over the beverage container issue.

Second, a recent OECD report comments that any beverage container policy would primarily relate to the 'off' premise sector of the beverage market [OECD (1978)].

Third, these carbonated beverage containers comprised the scope of the study of the U.K. situation that was recently performed by the WMAC [WMAC (1980)].

Fourth, the carbonated beverages represent a distinct sector of the packaged products market for which there used to exist an established and viable returnable system and in which the position of the returnable bottle has declined significantly recently (see table 1.3). Therefore, it is preferable that a review of the returnable versus non-returnable packaging issue should first concentrate upon this sector in order to examine whether the recent deterioration in this returnable system should be averted. If, and only if, it was considered feasible and desirable to re-establish and increase the use of the returnable system for beer, cider and carbonated beverages, then it might be

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(4) A bimetallic can is a beverage can with a tinplate body and base and an aluminium top with an aluminium ring pull closure for easy opening.

worthwhile to extend the review to other beverages and packaged products, such as wines and spirits and jam jars, for which a widespread returnable system has not existed recently and for which the problems of establishing a viable returnable system could be expected to be significantly greater than for the more traditionally returnable carbonated beverages.

1.4 Outline of the thesis

Part II presents the theoretical foundations of this thesis. Chapter 2 demonstrates the importance and need for a sound framework for analysing environmental issues. A general theoretical framework is then developed on the basis of economic theory and a review of the literature on social policy concerning environmental questions. This review highlights that the assessment of environmental impacts is of great importance in an analysis of environmental issues.

Therefore, in Chapter 3, this aspect is studied in depth. This chapter first identifies the principal objective of an assessment of environmental impacts and then examines critically the political and economic approaches towards the achievement of this objective. The various techniques that have been adopted or proposed in other studies are reviewed and the conceptual and practical problems of assessing environmental impacts are identified. This highlights the relative merits and shortcomings of economic evaluations and the other techniques, such as physical impact studies and concordance analysis. On the basis of this examination, this thesis develops a 'best practicable approach' which is appropriate for the evaluation of environmental impacts, such as those of carbonated beverage containers, for which significant data constraints are apparent.

Part III. The general theoretical framework, developed in Part II, is then applied in Chapter 4 to the specific issue of the environmental impacts of returnable and non-returnable beverage containers. Chapter 4 first provides a brief description of the beverage containers investigated in this study. Some criteria are then developed for the government to consider intervention in the market for packaged beverages. This highlights three important aspects: any absence of consumer sovereignty; the existence of any significant external costs; and the current consumption of finite resources, such as energy, which are considered to be incorrectly priced under the current market mechanisms. Chapter four then develops a framework for the evaluation of the alternative beverage container policy measures. On the basis of the 'Best Practicable' approach for the evaluation of environmental impacts developed in chapter 3, the final section of Chapter 4 presents a general methodology for the analysis of the five external cost areas relating to beverage containers. This sets out the following five questions which this thesis aims to answer:-

(1) Whether the activities result in any 'external' costs and, if so, in what manner?

(2) What is the nature and level of the overall external costs generated for the specific categories of externalities?

(3) What is the size and significance of the external costs generated by carbonated beverage containers? This will aid the determination of whether the government should consider intervention.

(4) What are the relative levels of the environmental impacts of the alternative returnable and non-returnable containers for carbonated beverages? This will aid the determination of the direction in which the government should consider intervening (i.e., favour returnables or non-returnables).

(5) What are the levels of the external costs that would be generated by carbonated beverage containers under various scenarios for 1982? This will act as an input into an evaluation of beverage container policies. In the scenarios analysed, different values are adopted for two important determinants of the economic and environmental impacts of beverage container policies - the market shares of the alternative containers and the trippage of the returnable bottle. The scenarios are as follows:-

- Scenario I is the position in the market for packaged carbonated beverages in 1977.
- Scenario II is the situation in the carbonated beverages market in 1982 if there is 'no action' or intervention by the government.
- Scenario III is the extrapolation of the current trends towards a greater use of non-returnables to

the extreme case where the non-returnable bottle and can completely replace the returnable bottle in 1982.

- Scenario IV is similar to scenario I in that it assumes that the returnable bottle maintains the market share and trippage achieved in 1977. The only difference between scenarios I and IV is that scenario IV relates to the larger 'off' premise market forecast for 1982.
- Scenario V depicts an intermediate increase in the market share of the returnable bottle, whose trippage also increases.
- Scenario VI is similar to the intermediate scenario V. However, under this scenario VI, the trippage of the returnable bottle does not increase.
- Scenario VII illustrates the predicted outcome in the market for packaged carbonated beverages after the implementation of a mandatory deposit regulation. This was the policy measure proposed by Friends of the Earth in their minority report to the WMAC [Cawdell (1980)].
- Scenario VIII is the converse of the other extreme scenario III. Scenario VIII is a complete 100 per cent returnable system.
- Scenario IX is similar to scenario VIII but a higher trippage, of 15, has been adopted in this scenario.

The 'NO ACTION' scenario II is used as the baseline for the comparison of the external costs generated under the various scenarios for 1982. The year 1982 was used for the scenario analysis since it has been advocated that any beverage container policy should be suitably phased in to mitigate any adverse economic mpacts upon industry. The WMAC suggested that a five year period would be required for this

[WMAC (1980)]. Consequently, a policy originally implemented in 1977, would become fully effective in 1982. Furthermore, this incorporates an important dynamic element into the analysis and enables identification of the environmental impacts resulting from a continuation, modification or reversal of the current trends in the market for packaged beverages.

Part IV contains the empirical analysis of the external costs of carbonated beverage containers.

Chapter 5 assesses the impacts arising from the generation of domestic waste and, in particular, from the disposal of carbonated beverage containers in domestic waste. This thesis reports the results of 131 analyses of the composition of the solid waste from more than 9,100 households in various parts of the U.K., ranging from Cornwall in the South-West of England to Dundee in the North-East of Scotland. These results, along with some materials balance calculations, are used to estimate the physical size of the carbonated beverage container component of domestic waste.

Chapter 6 examines the impacts of litter and, in particular, of littered beverage containers. A critical appraisal is undertaken of four litter composition surveys which give an indication of the size of the carbonated beverage container component of litter.

Chapter 7 considers the pollution impacts of the alternative beverage container systems in the form of the emissions of air and water pollutants and the generation of industrial solid wastes.

Chapter 8 examines the size, nature and significance of any public health and hygiene impacts arising from the presence of any contaminants in the packaged beverage and from the storage of the beverage containers at the retail outlets.

Chapter 9 considers the environmental impacts resulting from the transportation between the process stages involved in the alternative container systems. This chapter concentrates upon assessing the significance of the urban traffic congestion caused by the deliveries of carbonated beverage containers to the retail outlets.

On account of the apparent importance of the trippage of a returnable bottle, this subject is extensively investigated in chapter 10. Chapter 10 first presents the available data on the current levels of and trends in the trippage rates achieved in the U.K. and in various overseas countries. A model of the determinants of trippage is developed. Chapter 10 then reports and analyses the results of some research relating to the three parties involved in the return of empty bottles. This research comprised: a questionnaire survey of 1523 householders and schoolchildren; a questionnaire survey of the opinions and practices of 69 retailers; a practical bottle returning exercise in which a random sample of 8 bottles were taken back to 24 retail outlets and the characteristics of the rejected and accepted bottles noted; and interviews with five local and national bottlers and brewers. These surveys provide some empirical information which suggests why some

U.K. consumers currently do not return bottles and how the return rate or trippage of returnable bottles in the U.K. could be raised.

Chapter 11 details the conclusions of this thesis.

In addition, there are fifteen appendices. Appendix I presents an overview of the policy measures concerning beverage containers that have been adopted or proposed in a number of countries and international organisations. Appendix II gives details of the information and assumptions used to compile the scenarios for 1982. Appendix III contains the instructions sheet that was sent to the County Councils for the analysis of the beverage container component of domestic waste. This appendix also lists those Councils that undertook this analysis. Appendix IV gives the detailed data behind the materials balance calculations of the size of the carbonated beverage container component of domestic waste. Appendix V presents detailed information on the air and water pollutants generated by the various industrial processes involved in the returnable and non-returnable beverage container systems. Appendix VI presents two case studies of two specific process stages which illustrate how a pollution emissions study might be undertaken for the U.K. beverage container systems. Appendices VII, VIII and IX give the lists of the points on which information was sought from the bottlers, Environmental Health Officers and retailers in order to enable assessment of the significance of the hygiene impacts of carbonated beverage containers. Appendix X gives a list of points concerning the distribution of beverage containers on which information was sought from the traffic control authorities and from the distribution managers at beweries. Appendix XI shows the introductory letter that was sent to the households covered by the consumer surveys in Leicester and Blackburn. Appendix XII presents the questionnaire used for the consumer surveys in Leicester and Blackburn. Appendix XIII presents the questionnaire used for the retailers' surveys in Blackburn and Leicester. Appendix XIV gives details of the returnable bottles used in the bottle returning exercise. Appendix XV lists the various government agencies, private companies, universities, research institutions and other organisations which provided information and data for this study.

1.5 Methododologies adopted for the empirical analysis

The actual extent and detail in which the general methodology is followed for the study of each area of external costs depends upon the importance of each area and the availability of information for each area. A review of the literature and discussion with experts revealed that the generation of domestic waste and litter were likely to be the most important external impacts of beverage containers. Therefore, research and data collection efforts were concentated upon these two areas. Consequently, the impacts of carbonated beverage containers on domestic waste and litter are examined in the light of all five questions (1)-(5), noted earlier on pages 12 and 13, while the analysis of the other three areas (pollution emissions, hygiene and urban traffic congestion) focusses upon the specific and separable external impacts of carbonated beverage containers in these areas [i.e., questions (3)-(5)].

The thesis draws on the experience of other countries wherever this is relevant and useful. However, official U.K. bodies (such as the WMAC) have consistently emphasised that any U.K. decision on the beverage container issue should be made upon the basis of U.K. data. Therefore, the actual empirical analysis is based almost totally upon U.K. data and contains much original data and information on this subject. All the monetary figures are presented in terms of 1977 prices. Wherever important gaps in the current knowledge are apparent, these are identified along with important limitations concerning the available data and information that is presented.

1.6 Limitations of the study

A detailed economic evaluation is made regarding municipal waste management expenditures. However, data constraints prevented the derivation of such precise economic valuations for litter collection and control expenditures. The thesis highlights the limitations and uncertainty surrounding the monetary estimates presented for this latter aspect and outlines a methodology for deriving a more accurate valuation.

Lack of data also precluded the possibility of performing a full economic evaluation of the other external impacts of beverage containers. Consequently, the assessment of these unquantifiable impacts comprises a presentation of physical information on these impacts (e.g. the quantities of pollutants generated, the number of cases of contaminants being found in beverage containers), and qualitative information on the nature and significance of these impacts. This latter aspect is based principally upon a review of the opinions of the authoritative bodies engaged in the control of these impacts and the results of public opinion surveys. The assessment of the hygiene and urban congestion impacts of beverage containers is supplemented by the provision of approximate 'ball park' monetary valuations which indicate the order of magnitude of these external costs.

This qualitative assessment of these other external impact items is subject to some limitations, which are particularly pronounced in relation to the aesthetic impacts of littered beverage containers, the impacts of the air and water pollutants and industrial solid wastes generated by the beverage container systems and the environmental impacts of the transportation required for the beverage container systems. A possible methodology is developed which outlines the further information and data needed if a more detailed economic evaluation of these impacts would be desired and if more resources should be available for the acquisition of this information.

The analysis of environmental impacts of the beverage container systems' transportation requirements in Chapter 9 concentrates on examining the external congestion costs arising when beverage delivery vehicles are parked in the streets to deliver to the retail outlets. It was considered that this is the area where a move from non-returnables to returnables would be likely to have the most significant impacts. Therefore, efforts were first directed towards this area and an evaluation was not made of the other congestion impacts of beverage distribution (e.g. delays caused by the presence of the lorries in the traffic stream and by beverage delivery vehicles in off-street servicing areas) and the other environmental impacts of the beverage container systems' transport requirements (e.g. road track costs, accidents, noise and vibration). The limitations due to these omissions are highlighted and a possible methodology is developed in Chapter 9 for the evaluation of these impacts.

For one area (air and water pollution emissions), it was not feasible to obtain sufficient U.K. data so that overseas data had to be used. However, it is acknowledged that this overseas data may not be directly applicable to the position in the U.K. beverage market. Consequently, this overseas data have been adjusted to allow for the major differences between the beverage container systems analysed in the overseas study and the current situation in the U.K. This should yield a reasonable indicator of the relative air and water pollution emissions generated by the alternative container systems for carbonated beverages. In addition, Appendix VI of this thesis presents case studies on two specific process stages of the beverage container systems which illustrate how a U.K. pollution emissions study might be performed, if it should be considered necessary to obtain actual U.K. data for this area.

The analysis does not allow for any reduction in the weights of returnable and non-returnable containers that might occur between 1977 and 1982 since it was not possible to obtain any 1982 data on the weights of the various sizes of containers. The study does not cover plastic non-returnable bottles which were recently introduced into the carbonated soft drinks market. Similarly, the analysis does not incorporate any new types of beverage containers which might be developed, since it was not possible to determine the (hypothetical) impacts of such new containers.

This thesis does not consider the consumption of energy and raw materials by the beverage container systems, since this aspect had already been studied in depth by expert energy analysts at the Open University [see Boustead and Hancock (1981)]. The thesis also does not include a detailed investigation of whether there is any absence of consumer sovereignty in the market for packaged beverages, although the trippage surveys do provide some interesting information on this matter.

The information presented in this thesis constitutes an <u>input</u> into an evaluation of beverage container policies. The thesis does not attempt to formulate and select the optimum policy for carbonated beverage containers[5] in the U.K. since it was not possible to obtain the confidential

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(5) The thesis does not examine one particular policy measure that has been proposed - the promotion of recycling of post-consumer waste materials such as glass, metal and plastic containers. This subject has been extensively studied in two recent OECD reports [OECD (1978, 1983)].

information required on the (hypothetical) economic impacts of the alternative policy measures on the various sectors of the beverage industry. After consultations with officials at the Department of the Environment and with experts in the beverage industry, it was decided to concentrate upon performing a thorough study of two specific aspects: the external costs of carbonated beverage containers and trippage. In this way, it was considered that the research would usefully complement the other work that was being undertaken by other groups and organisations and could most effectively contribute to the current beverage container debate.

P A R T I I

THEORETICAL FOUNDATIONS OF THE STUDY

CHAPTER 2

THEORETICAL FRAMEWORK

Introduction

Chapter 1 showed that there was concern among consumers and environmental groups about returnable and non-returnable beverage containers and that this prompted the United Kingdom's Waste Management Advisory Council (WMAC) and the EEC's Environment and Consumer protection service to undertake a substantive review of this issue. It is important to establish precisely and clearly a conceptual framework for such a study; much of the current literature has failed to do this.

The current chapter develops a conceptual framework for studying general environmental issues. In chapter 4, this general theoretical framework is then applied to the specific environmental problem examined in this thesis: the environmental impacts of returnable and non-returnable beverage containers.

- Section 2.1 of this chapter demonstrates the importance of a sound framework for analysing environmental issues.
- Section 2.2 then develops a general framework on the basis of the economic theory and literature concerning social policy regarding environmental questions.

2.1 The need for a framework

It is important to delineate a framework for studying an environmental issue since an absence of a sound framework can result in poor decisions. Thus the decision may be based on emotional exaggerations and misrepresentation rather than a rational analysis of the relevant factors. In particular: some irrelevant aspects may be inappropriately included; some factors may be incorrectly analysed or given an incorrect weighting; and some relevant and important impacts may be omitted or hidden and ignored.

There are examples in the cost-benefit analysis literature of such shortcomings having arisen. Thus, Pearce and Nash (1973) have shown that a study of an urban motorway scheme failed to take into account various qualitative impacts of the motorway on the local community and they state that this raised serious doubts about the previously announced viability of the scheme. Pearce (1974, p.16) also comments that, in the analysis of general environmental problems such as pollution, "there is a well-known tendency to ignore the unmeasureable or at least afford it a lower weight than the measureable". Furthermore, Pearce and Nash (1973) stress that the study of the urban motorway scheme failed to consider alternative transport options, such as public transport improvements, which they argue would yield greater social benefits. Therefore, they state that the study failed to fulfil cost-benefit analysis' central goal of identifying that policy option which yields the maximum excess of social benefits over social costs. Similarly, other transport studies (e.g., Bristol Area Land Use Transportation Study) have been criticised for failing to consider the possible interrelationships of land use planning and transport policies.

In relation to the debate and discussion over London's third airport, Mishan (1970) expressed concern that the Roskill Commission did not examine the fundamental question of whether or not the construction of a third London airport was necessary at all, but only compared the costs of building the airport at four alternative sites. Mishan's criticisms are levelled not so much at the Commission's performance of the empirical work which he says is thoroughly undertaken, but at the terms of reference for the Commission, the framework within which the study was undertaken and the manner in which its results were presented and interpreted.

In the specific context of the beverage container issue, there are also examples of conceptual errors being made in the current literature on this subject(1). Thus Pearce and Spence (1975) state that, in relation to the question of 'over-packaging', there is a failure to distinguish adequately between internal and external costs and benefits in some papers [e.g., Glass Manufacturers Federation (1973), Industry Committee for Packaging and the Environment (INCPEN) (1976)]. In particular, Pearce and Spence state that some authors argue or imply that, on account of the internal benefits and cost savings created by packaging, there does not exist any problem of 'over-packaging'.

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(1) This literature is comprehensively reviewed in Stern (1975), Maryland Department of Economic and Community Development (1976), OECD (1978) and Fisher (1978). Therefore, it is not reviewed in any detail here. Rather the synopsis presented highlights some examples of the conceptual errors that have been made in this literature.

The INCPEN (1976) paper argues that the consumers do already pay for the 'external' costs of the disposal of packaging in domestic waste on account of the inclusion of waste management costs in the rates paid by householders. However, as is demonstrated later in chapter 5, this payment of waste management costs through the current rating system does not remove the 'external' nature of the costs of disposing of the waste generated by an individual consumer.

Many studies of the impacts of beverage container legislation primarily comprise a comparison of the post- with the pre-legislation situations [e.g., Applied Decisions Systems (1974), Statens Offentliga Utredningar (SOU) (1974)]. However, what is really required is a comparison of the policy 'ON' with the policy 'OFF' situations. Furthermore, Stern et al (1975) state that some papers (e.g., Environmental Information Service) have drawn spurious conclusions regarding the fall in beer and soft drinks sales that occurred in Vermont following the implementation of beverage container legislation, since they fail to give consideration to the other factors that contributed to this drop in sales (e.g., the weather, the reduction in tourists).

The more elaborate impact studies do delineate and compare the policy 'ON' with the policy 'OFF' situation [e.g., Stern et al (1975), Research Triangle Institute (1976), Maryland Department of Economic and Community Development (1976)]. Nevertheless, many of these elaborate impact studies still merely itemise their findings for the various categories of impacts. Thus, in relation to the economic impact categories, Stern et al (1975) present data on the impacts of beverage container legislation on: filling and distribution costs; beverage sales; and the profits, capital investments, employment and earnings levels in the beverage industry. The study by the US Department of Commerce (1975) details data on the impacts of beverage container legislation upon employment levels, the price of beverages and capital investments. However, in these and also in other studies [e.g., United States Environmental Protection Agency (US EPA) (1972), Applied Decisions Systems (1974)], there is a failure to acknowledge and demonstrate clearly the element of overlapping involved in some of the economic impact items listed. For example, the impacts of beverage container policies upon employment levels and the extra capital investments required as a result of a shift towards a greater use of returnables are some of the internal costs that make up the total internal costs of producing and delivering beverages which, to a certain extent, affects the price paid by consumers. Consequently, a false conclusion could be drawn by the reader from this presentation of data on various impact categories, where there is a failure to highlight the existence of any double counting and a failure to demonstrate clearly any special characteristics of a particular impact category that merit its separate inclusion in the analysis(2).

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(2) Exceptions to this are the OECD Report [OECD (1978)] and the study by Maryland Department of Economic and Community Development (1976), in which a cost-benefit framework was elaborated and adopted. This subject is examined further in the framework for the evaluation of beverage container policy measures that is developed in Chapter 4 of this thesis.

Therefore, it is essential to develop a sound conceptual framework for a study. The following section draws on current economic theory and literature concerning social policy to develop a conceptual framework setting out the major relevant factors that it is necessary to consider in the analysis of environmental issues.

2.2 A conceptual framework

Economics is concerned with the allocation of scarce resources and with the choice between the alternative uses of these scarce resources(3) [Arrow and Scitovsky (1969), Bohm (1973, p.1), Nijkamp (1977)]. Thus Nijkamp (1977 p.1) states that:

> "Economics is traditionally oriented towards choice and decision problems. In particular, it concentrates on the manner in which man employs scarce resources which can be used in alternative ways."

Kneese and Bower (1972) point out that the growth in the concern over environmental problems requires a social choice and decision on the part of the government. Thus a branch of economics, environmental economics, developed for the analysis of the social choice and decision-making process for these environmental issues.

The literature on environmental economics and externalities has been extensively reviewed elsewhere [e.g., see Mishan (1969), especially Chapters 1 and 7, Nath (1969), Bohm (1973), Baumol and Oates (1975)]. This thesis draws on the theoretical analysis in these studies and the salient points

(3) Culyer (1973, p.17) refines this somewhat by saying that economics is about marginal choices.

relating to social decisions on environmental issues are presented summarily here[4].

The conceptual approach adopted here is based on the premise that the government, and the environmental economist, should be considering whether the free market mechanism is currently functioning efficiently[5]. This premise follows the distinction between private and social efficiency. The point of private efficiency is the outcome that is currently generated by private market forces. Social efficiency is defined in terms of the achievement of the greatest social welfare for the whole community - or the attainment of the social optimum.

This approach highlights two major sequential stages in the decision-making process on environmental issues:-

Stage (I) - Stage I comprises an analysis of the causes, size and significance of any divergence between the current position generated by market forces and the socially efficient optimum.

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(4) Externalities also have theoretical implications for welfare economic theory (e.g., concerning the existence of an equilibrium and the derivation of the conditions for the attainment of the social optimum in the presence of externalities). These theoretical aspects are not examined in this thesis which concentrates upon the practical issues concerning the policy and decision-making process on environmental issues. A similar procedure was followed by Baumol and Oates (1975, p.9) who stated that: "our exclusive concern with the theory of policy dictates the omission of the issue of the existence of a general equilibrium solution in the presence of externalities." For an examination of these theoretical aspects, see Mishan (1969).

(5) This approach is similar to that of Krutilla (1981) who advocates that applied welfare economics should be concerned with examining whether improvements in the current position and welfare levels could be attained.

Stage (II) - If any significant difference exists, then the next stage should be undertaken, which is an evaluation of all the alternative policy measures (including the 'No Action' option).

2.2.1 Analysis of the causes of a divergence between the current market position and the social optimum.

A divergence between the current market position and the social optimum will be caused by any imperfections in the current market mechanism - or what Bator and others have referred to as market failure [Bator (1958)]. There are a number of possible causes of market failure. These include the existence of: Externalities; Public goods; Imperfect information; Incorrect pricing and depletion of finite resources; Indivisibilities of consumption and production units; Increasing returns; and Monopoly. An analysis of various aspects of market failure is given in Bator (1958), Nath (1969), Bohm (1973) and Baumol and Oates (1975). Many of the studies and papers relating to this subject have focussed upon particular aspects of market failure [e.g., see Meade (1952), Freeman et al (1973), Baumol and Oates (1975)]. This thesis does likewise and concentrates upon three aspects of market failure that are particularly relevant to the beverage container issue:-

(i) - Imperfect information

(ii) - Externalities

(iii) - Incorrect pricing and depletion of finite resources

2.2.1(i) Imperfect Information

Nath stresses the importance of the distinction between imperfect information and externalities when he states [Nath (1969, p.91)] that:

> "the effects of imperfect knowledge... are to be distinguished from those of externalities; though both imperfect knowledge and externalities - separately and together - constitute a market failure".

Both consumers and producers may not have perfect information to make their production and consumption decisions. However, Bohm (1973, p.58) notes that:

> "Producers' information about present market conditions seems to be less of a problem since companies normally may be assumed to have more resources for these purposes and more relevant technical know-how than individual consumers."

Therefore, this thesis concentrates upon the information problems of the consumer[6] and analyses whether there is any difference between the actual situation faced by consumers in the real world and the axioms and assumptions concerning consumer behaviour that underly the optimum in the perfectly competitive model of neoclassical welfare economics. The main assumptions are:

(a) that individuals are able to form their own 'rational' preferences for goods and that the individuals' preferences are to count as measures of social welfare;

(b) that consumers have a complete choice between the full range of available alternatives and have perfect information to make their choices.

Bohm (1973) demonstrates that, if there is imperfect information and knowledge, then this could prevent the market mechanism from 'on its own' attaining the socially optimum level for the community.

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(6) Nevertheless, the examination of the prices and depletion rates of finite resources in section 2.2.1(iii) does include consideration of whether one group of producers - owners of finite resources - have imperfect information and knowledge about <u>future</u> prices and markets.

It has been suggested by some authors that consumer sovereignty may not be apparent in the current market place since consumers lack information and do not have a complete freedom of choice on account of the distorting effects of advertising on private wants and consumption levels [see Packard (1960), Galbraith (1968), Lecomber and Fisher (1978)]. Some credence to these views is given by the need for official bodies such as the Advertising Standards Authority, the Consumers' Association and the Consumer Advice Centres.

2.2.1(ii) Externalities

Buchanan and Stubblebine (1962, p.371) highlighted the importance of externalities when they stated that:

> "In its various forms - external economies and diseconomies, divergences between marginal social and marginal private cost or product, spillover or neighbourhood effects, collective or public goods - externality dominates theoretical welfare economics and in one sense, the theory of economic policy generally."

Definitions

Bator (1958) adopts a broad interpretation of the term externality so that it covers many major causes of market failure. In particular, Bator (1958) includes both the problem of increasing returns to scale as well as what he refers to as public good externalities, such as environmental pollution. However, Baumol and Oates (1975) advocate that this broad interpretation of externality is inappropriate since the increasing returns problem is quite different from that of the more conventional externalities such as damages to the environment. Therefore, they propose that a narrower interpretation of the term should be adopted. This thesis follows Baumol and Oates' narrower and more conventional interpretation of externalities. Hence, increasing returns are not included in this analysis.

Buchanan and Stubblebine (1962) define an externality as arising where there is an interdependence between the consumption or production functions of different individuals - i.e., where one individual's welfare is affected by the activity of another individual.

However, Nath (1969) points out that such interdependence need not necessarily constitute an externality since, if there was some trading and payment between these two individuals concerning this interdependence, then this operation of market forces would ensure that the interdependent effects were taken into account by the individual unertaking the activity and would mean that the actual level of this activity would be pareto optimal for both individuals. Therefore, Nath (1969) demonstrates that it is also necessary to add a second condition to yield a complete definition of an externality. This second condition is that the interdependence between the individual consumers and producers is not transmitted through market forces. This second condition means that an externality arises where individual A makes or receives no payment for the impacts that he has on individual B and consequently where individual A does not take into account these impacts on B in determining his consumption or production decisions. These two conditions for externalities are neatly and concisely summarised by Arrow and Scitovsky (1969, p.183) when they refer to externalities as "non-market interdependence".

On the basis of these two conditions, this thesis adopts the following definition of external costs and benefits. (For completeness and for purposes of comparison, a definition of internal costs and benefits is also presented).

- External costs and benefits arise where the actions of a consumer or producer affect the welfare of other members of society, and where there are no traded markets or property rights concerning these impacts. Consequently, under the current market system, there is no incentive or compulsion for the individual producer or consumer to take these impacts into account in their production or consumption decisions. As a result, these external impacts are imposed on society as a whole and remain uncompensated (if they are costs) or unappropriated (if they are benefits).
- Internal costs and benefits are the factors that the individual manufacturer or consumer does take into account in his production and consumption decisions. These factors are therefore included in his production or consumption function for a good.

Categories of externalities

Technological Externalities

Baumol and Oates (1975) stress the importance of the distinction made by Viner (1931) between 'technological' externalities and 'pecuniary' effects and argue that a failure to recognise this distinction has led to errors in the past. 'Technological' externalities arise when an activity (e.g., the emission of pollutants from a factory) affects the welfare of other members of society and these impacts are not transmitted, under free market forces, to those undertaking the activity so that they will not be taken into account in the production decisions concerning the activity. Hence, 'technological' externalities conform to the definition of externalities given earlier. 'Pecuniary' effects also arise when an activity affects the welfare of other parties that are not directly related to those undertaking the activity. For example, an increase in the demand for aluminium cans raises the price of wrought aluminium which raises the price of other aluminium products (e.g., foil). This increase in demand can affect the welfare of the manufacturers of wrought aluminium whose income rises, and the welfare of purchasers of aluminium foil whose real disposable income falls. However, the distinction between these two types of effects is that the 'pecuniary' effects arise from the interdepenencies between (separate) parties that are transmitted through normal market forces. Thus, the pecuniary effects do not comply with the second condition in the definition of externalities given earlier. The 'pecuniary' impacts result in changes in the welfare of certain groups of society and in changes in the basket of goods society consumes, i.e., movement along the production frontier. However, they do not cause any shift in the production frontier or any changes in the manner in which a good (e.g., aluminium) ought to be produced since they do not imply that there is any divergence between the social and the private costs of the processes involved in the production of a good. Hence, the existence of any 'pecuniary' effects does not create any divergence between the marginal private and the marginal social rate of transformation. Therefore, they are termed 'pseudo-externalities' by Baumol and Oates (1975).

Externalities have also been classified into various other categories. These include: depletable/undepletable; reciprocal/unidirectional; marginal/infra-marginal; separable/non-separable; potentially relevant/potentially irrelevant; and Pareto-relevant/Pareto-irrelevant. These categories are reviewed and analysed in detail in Buchanan and Stubblebine (1962), Nath (1969), Mishan (1969, Ch.7), Baumol and Oates (1975) and Nijkamp (1977). This thesis briefly considers three categories of externalities that are important for policy and decision-making on current environmental issues: marginal and infra-marginal; potentially relevant and potentially irrelevant; Pareto-relevant and Pareto-irrelevant.

Buchanan and Stubblebine (1962) define a marginal externality as being where a marginal change in the level of an activity (I) undertaken by an individual producer or consumer (A) has external impacts on the welfare of other members of society (B). They define an infra-marginal externality as being where, over a certain range of output levels, marginal changes in the level of activity (I) will not affect the welfare of other members in society.

Buchanan and Stubblebine (1962) state that a potentially relevant externality exists where the activity (I) generates a desire on the part of the externally affected party (B) to modify the action of (A). This category includes marginal externalities, but would only include infra-marginal externalities in cases where there is a sufficiently large change in the level of activity (I) so that the welfare of (B) is affected. The existence of potentially relevant externalities means that there is a divergence between the social and private marginal rates of transformation and substitution. Therefore, an investigation of whether any significant potentially relevant externalities arise under the current private market mechanism forms an important component of an examination of whether there is any difference between the current private position and the social optimum.

Buchanan and Stubblebine (1962) then go on to distinguish between Pareto-relevant and Pareto-irrelevant externalities. They define a Pareto-relevant externality as being where the activity (I) can be modified through trading or bargaining between the parties (A) and (B), which leaves the externally affected party (B) better off without making the externality generating party (A) worse off. As Nijkamp (1977) points out, this category is relevant to the question of the optimum reduction in the level of the externality. Therefore, this category and its underlying principle, are considered further in the evaluation of policies for the correction of externalities (see section 2.2.2).

2.2.1(iii) Incorrect pricing and depletion of finite resources

This section considers market imperfections relating to finite resources, such as energy. This subject must be distinguished from the earlier static analysis of externalities since such finite resources command a price in the current market place. The current consumption of finite resources is different and notable in that it involves the question of the intertemporal allocation between the consumption of a finite resource in current and future time periods. This question incorporates an analysis of what Simmons (1975, p.177) refers to as 'dynamic' externalities.

At present there is considerable concern and debate about the price and depletion of finite resources, such as energy, and there have been many investigations and studies relating to this subject. In the context of the beverage container issue, there has been a proliferation of comprehensive and detailed energy analyses of beverage container systems [e.g., see Ontario Solid Waste Task Force (1974), US EPA (1974), Bunt (1975), INCPEN (1975), Research Triangle Institute (1976), Boustead and Hancock (1981)].

However, energy analysis has been subject to considerable criticism [e.g., see Pearce and Webb (1975)]. In particular, the critics stress that some energy analysts ignore the internal cost aspect of energy use which, as has just been noted, is represented by its market price and that they fail to demonstrate whether this current market price of energy is lower than the long run social opportunity cost of this finite resource, and if so why and in what direction.

There is considerable controversy amongst both economists and non-economists over this question. Thus Pearce and Rose (1975 p.9) point out that:

> "Apart from being naturally disputatious, ..., economists do disagree about the 'proper' way to look at resource depletion. For example, there are widely divergent viewpoints about the optimal rate of depletion, centring on the extent to which the standard neo-classical approach based on the maximisation of some present value of future flows of consumers' surplus adequately allows for future generations' well-being."

Therefore, there is a need to examine carefully this question. Heal (1975) and Lecomber (1979) suggest that this examination should centre upon whether there are any imperfections in the current private market for finite resources. Thus Lecomber (1979, p.81) states that:

> "It is a standard piece of economic theory that a perfect market mechanism guides the economy to a social optimum in which the 'best' combination of goods is produced according to the most efficient processess......... The conservationist critique of resource use implies misallocation and this must be attributable to some form of market failure. Both to assess this critique and to devise appropriate remedies it is useful to identify specific sources of market failure."

Therefore, this section sets out to identify the major imperfections concerning the resources market and to ascertain whether these imperfections create biases towards over- or under-exploitation of finite resources.

This review here will not go into the complex details of this matter which are well covered elsewhere [e.g., see Lecomber (1979) and the Conference papers presented in Pearce and Rose (1975)]. This section briefly examines some of the salient issues.

The analysis commences with a presentation of a simple general model of the private market mechanism for the determination of the current extraction level of a finite resource. A socially optimal model is then outlined and this forms a benchmark which is used to highlight the imperfections concerning the current private market mechanism for finite resources.

The Private Market Mechanism for Finite Non-renewable Resources

According to the standard economic theory, a private resource owner will seek to maximise the present value (V) of his present and future returns from the resource[(7)].

$$\text{i.e., } \max V = \int_0^T (P_t - C_t)\, e^{-it} \qquad 2.3$$

where :-

T	=	His finite time horizon
P_t	=	The (estimated) price of the resource over the period t.
C_t	=	The (estimated) costs of extracting the resource over the period t.
i	=	His rate of interest.

This will result in setting the price of the resource over the time period t (P_t) equal to the marginal private costs of the resource over the period t (MPC_t).

$$P_t = MPC_t \qquad 2.4$$

The marginal private costs of the resource contain two components: the marginal private costs of extracting the

(7) This model is similar to that developed in Pearce and Rose (1975, p.16) and Kay and Mirrlees (1975).

resource (MPC_t^{EX}) and the marginal private cost of using up the finite stock of the resource, also referred to as the resource rental (MPC_t^{RR}). Thus 2.4 becomes:

$$P_t = MPC_t^{EX} + MPC_t^{RR} \qquad 2.5$$

Marginal extraction costs generally fall over time due to technological improvements. However, just before depletion, they rise since it becomes more difficult and costly to extract resources from inferior sources. The resource rental component is very low when the resource is plentiful and rises as the resource is depleted. This is shown diagrammatically in Fig. 2.1 which also illustrates the resulting price path (--------) that is the vertical summation of these two cost components.

<u>The social optimum for finite resources</u>

The social optimum will be that maximizes the net social value (V*) from the present and future use of the resource. This is represented by:

$$\text{MAX} \quad V^* = \int_0^{T^*} (P_t^* - C_t^*)\, e^{-rt} \qquad 2.6$$

where:-

T^* = Society's time horizon

P_t^* = The price of the resource over the period t.

C_t^* = The social costs of extracting the resource over the period t.

r = Social discount rate.

The price of the resource (P_t^*) will then be equal to the long-run marginal social costs of the resource. This comprises the marginal social costs of extracting the resource (MSC_t^{EX}) plus the marginal social costs of using up the finite resource (MSC_t^{RR}).

$$P_t^* = MSC_t^{EX} + MSC_t^{RR} \qquad 2.7$$

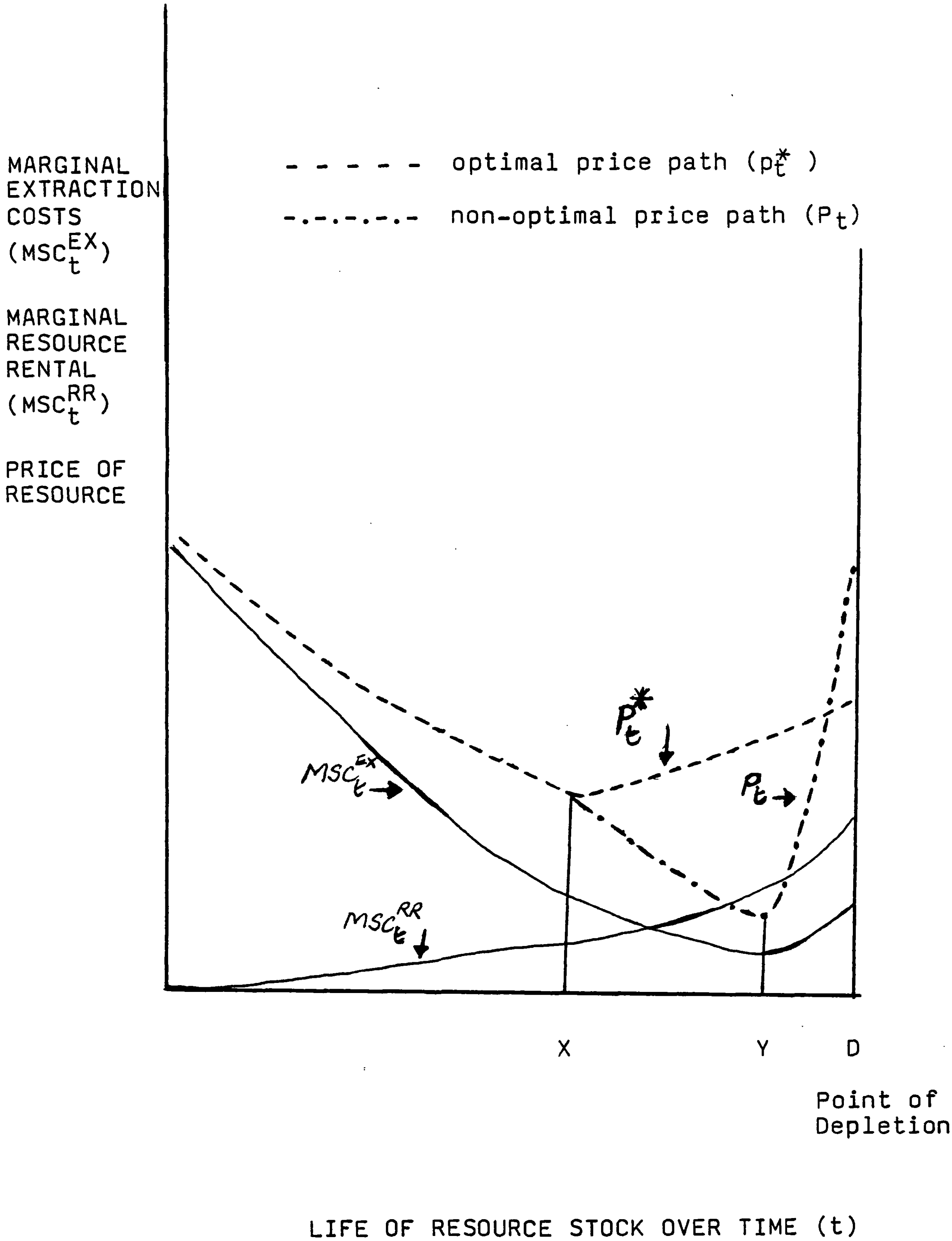
<u>Private market incentives for conservation</u>

The private market mechanism provides some incentives for conservation through the resource rental component (MPC_t^{RR}). The resource rental component is (the discounted value of) the resource owner's return from extracting the resource in the future instead of the present. This resource rental component is determined by the resource owner's expectations concerning the price and extraction costs of the resource in future time periods, which will be affected by the forecasts of the future demand and supply of the resource. The extraction rate will be set such that the return from the resource owner's not disinvesting in his resource stock (i.e., not extracting the resource now) will equal his rate of interest.

Thus, under the current market system, an allowance is made for the demands of future generations and the possibility of resource depletion through their impact upon the resource owner's predictions for future prices of the resource.

If this market mechanism was functioning perfectly so that the resource owner did correctly predict and take into account future price rises, then this would result in an

Figure 2.1 Price paths over life of resource stock



optimal price and depletion path, such as the path ------- illustrated in Figure 2.1 which shows that the price of the resource would start to rise at point X. Resource optimists argue that this period of rising prices (XD) will enable the exploitation of new resources and the development of new technologies and alternative sources which will replace or reduce the need for this resource before it is depleted so that a problem of resource scarcity will not arise.

However, there are a number of factors which could inhibit the perfect functioning of this market system and could prevent it from leading to the attainment of the social optimum.

Imperfections in the market for finite resources

The lack of a futures market and the existence of uncertainty concerning future resource prices

Doubts have been raised about the resource owners' ability to forecast these future prices perfectly on account of information constraints and the lack of a futures market for finite resources such as oil [e.g., see Heal (1975), Lecomber (1979)]. The future prices of the resource will depend upon the interaction of a number of complex factors. These include: economies in use; discovery of new reserves; technological improvements; the development of alternative sources; and the acceptability (on both economic and environmental grounds) of these new reserves and alternative sources (e.g., nuclear power). This makes the forecasting of future resource prices very difficult and inevitably subjective. Thus Surrey and Page (1975, p.67) conclude that:

"Knowledge about the ultimate size of world mineral resources is fragmentary...... There is simply no way of accurately assessing world reserves of 'so-called' non-renewable resources, nor of anticipating which materials will constitute usable resources in the future. Attempts to forecast how long the reserves will last ultimately reflect the forecasters' subjective pessimism or optimism about the future".

Similarly, Lecomber (1979, p.90) states that:

"Price expectations are not formed very explicitly beyond the next few months or perhaps years. Partly this reflects the rate of time preference, of which more will be said later, but largely it reflects the feeling that in the face of such enormous uncertainty regarding ultimate resource stocks and technical developments, elaborate forecasting is not worthwhile."

Consequently, Heal (1975) and Lecomber (1979) suggest that these forecasts for future prices will be based, at least partly, on an extrapolation of past trends. Figure 2.1 shows that, due to falling extraction costs, resource prices will be falling (up to the point X) so that the resource owner at point X will accordingly predict that further declines in resource prices will occur in the future. This would encourage greater resource extraction which will reduce the price (a self-fulfilling prophesy). In addition, Kay and Kirrlees (1975) point out that expectations tend to be revised discontinuously. Therefore, this could further delay the point at which any necessary revisions of expectations are made on account of the growing importance of finite resource constraints and rising resource rentals. At this point (Y), the price of the resource rises sharply to adjust for the earlier underestimation of the price of the resource. This will lead to a non-optimal price path being followed and it is evident in figure 2.1 that, under this price path -.-.-., the period of rising prices is much shorter (YD instead of XD). Conservationists and resource pessimists have expressed doubts and concern over the economy's and society's ability to adjust and find alternative sources in time before the resource is depleted.

Risk aversion

If the resource owner is risk averse, then he will place a premium upon a definite current income as opposed to a future income which is uncertain on account of the various exogenous factors affecting the future value of the resource. Lecomber (1979) states that most individual producers are highly risk averse. Therefore, this factor will also lead to excessively rapid rates of resource depletion(8).

Ownership Uncertainty

In addition to uncertainty about economic and technological variables, the resource owner may also face political uncertainty concerning the risks of an increase in the royalties charged or even an expropriation of their resource extraction operations by national governments. Such political uncertainty would encourage the resource owner to raise the current rate of resource depletion.

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(8) However, Kay and Mirrlees (1975) also suggest that there will be insufficient exploration for new reserves on account of risk aversion and the public good nature of the information on resources thereby generated, which would have a counteracting effect upon resource depletion. Nevertheless, as Lecomber (1979) points out, many national governments give tax concessions and assistance to the resource extraction industry which tend to offset this.

The social discount rate vs. the market rate of interest

The rate of interest plays the important role of an inter-temporal price in the decision on the current or future extraction of a resource. Generally, a higher interest rate will result in more rapid depletion since it discourages investment in the conservation of the resource[9]. It is advocated by the proponents of economic growth [e.g., Tobin (1964)] as well as by conservationists [e.g., Lecomber (1979)] that the social discount rate (r) is lower than the current interest rate (i) so that this leads to insufficient investment and provision for the future[10].

The proposed causes of this inadequate provision for the future include: imperfections in the capital market; and favourable externalities associated with certain forms of investment, such as research and development. Lecomber (1979) demonstrates that taxation acts as a disincentive against saving so that the marginal return on saving is less

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(9) However, Lecomber (1979) also notes that resource extraction is highly capital intensive so that investment in this industry will be discouraged by a rise in the interest rate. Consequently, it is also possible that a rise in the rate of interest could lead to a fall in the rate of resource extraction.

(10) Kay and Mirrlees (1975) comment upon this paradoxically similar stances of the conservationists and the proponents of growth and suggest that this implies an inconsistency on the part of the conservationists. However, Lecomber (1979) correctly demonstrates that there is no such inconsistency since the lowering of the interest rate would discourage current consumption and, although it would encourage investment, it would also give particular encouragement to resource conserving investment (e.g., the development of low-waste technologies).

than the marginal returns on investment. Consequently, social welfare would be increased if there was a rise in the supply of loanable funds (savings) for investment(11). The government appears to acknowledge this problem and attempts to offset this bias by giving tax allowances and grants for investment. However, Lecomber and Fisher (1978) state that these measures act selectively and unevenly. In particular, the grants and allowances are given mostly for investments in manufacturing industry. In contrast, less assistance is given to other valuable forms of investment, such as labour training, and no offsetting assistance is given for one form of providing for the future - the conservation of resource stocks. Thus, there may be an inadequate level of provision for the future in general and, in particular, an insufficient level of resource conservation.

Myopia and the short-term planning horizon(12) of current decision-makers in general, and the resource owner in particular, may result in insufficient weight being given to the future benefits and the interests of future generations.

The importance that should be attached to the welfare of future generations depends upon the social and economic prospects for the future. These vary from

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(11) This matter is discussed in greater detail in Lecomber and Fisher (1978).

(12) In terms of the equations 2.3 and 2.6 given earlier in the presentation of the private and social optimum models for the allocation of finite resources, this suggestion means that the resource owners' finite time horizon (T) for planning and decision-making is shorter than society's time horizon (T*).

pessimistic scenarios [Meadows et al (1972), Mesarovic and Pestel (1975)] to optimistic forecasts of a continuation of the past trends of rising real income [Beckerman (1974)].

Environmental impacts of resource extraction industries

One source of imperfection is the environmental impacts generated by the extraction, processing and combustion of the resources, which result in the social costs of resource extraction (MSC_t^{EX}) exceeding the private costs that the resource owner pays for the extraction of the resource (MPC_t^{EX}). In the light of this imperfection, private market forces will lead to an excessive level of resource extraction.

The environmental impacts of resource extraction constitute technological or environmental externalities which were analysed in the previous section 2.2.1(ii). This means that if a study of a subject, such as beverage container systems, includes investigations of externalities and the consumption of finite resources, then it would be important to note this overlap and ensure that the external environmental impacts associated with resource extraction were not counted twice in the overall analysis.

Existence of monopoly

Buchanan (1969) pointed out that the presence of market imperfections (e.g., monopoly) raises doubts and complications concerning the conclusion, based just upon the existence of externalities in the perfectly competitive market, that the output level of an externality generating firm exceeds the socially optimum level. Thus, the monopolist produces at the point where MC = MR and hence raises prices and restricts output to a level that could already be lower than the socially optimal level.

Kay and Mirrlees (1975) advocate that the OPEC monopoly results in the current level of resource extraction being too low and the current price too high.

However, there is some uncertainty and controversy over the specific effect of just the monopoly element in raising resource prices and lowering current extraction rates. The (rising) price of oil exceeding the average extraction costs has often been cited as a measure of the size of the distortion resulting from the OPEC monopoly. However, Lecomber (1979) states that the price should equal not the average extraction costs, but the (long run) marginal social costs of the resource which, as was shown earlier, should contain an element for the depletion of this finite resource (see equation 2.7). Therefore, the increases in oil prices could be partly due to a growing importance being attached by the oil producers to resource depletion. Heal (1975) gives some support to this view when he states [Heal (1975, p.136)] that:

> "On this interpretation of events, it seems that the change in the market behaviour in the early 1970s followed as asserted earlier, not from any fundamental economic changes, but from changes in people's interpretation of the economic circumstances, and in particular from changes in their interpretation of the long run balance between supply and demand in the oil market...... market behaviour only began to change when traders came to place increasing emphasis on the long run balance of supply and demand, and during the earlier 1970s, this factor began to dominate the formation of price expectations and hence the behaviour of prices."

The inclusion of monopoly considerations introduces another and distinctly different dimension to the analysis. Thus, the foregoing analysis has considered imperfections in the intertemporal allocation of the resource and the externalities associated with the extraction of the resource. The existence of monopoly concerns imperfections in the current market structure for resources. These aspects have to be treated separately. They have different implications for questions concerning the current level of resource consumption and for the determination of the appropriate corrective policy measure. Thus, Surrey and Page (1975, p.57) point out that:

> "A 'crisis' stemming from monopolistic exploitation of resources is potentially no less dangerous than one stemming from fears of longer-term physical resource depletion. But for policy formulation the difference is vitally important."

In this respect, the existence of an outside monopoly power, such as the OPEC oil cartel, raises an important national rather than a global issue concerning resources. Thus the raising of the price of oil by OPEC causes economic and social problems for importing countries which create a desire, at a national rather than global level, to reduce the level of energy consumption. This has resulted in many countries taking measures to reduce their energy consumption and dependence.

To sum up: It is evident that the question of whether energy and, perhaps, other raw materials are under- or over-priced and the importance that should be attached to this distortion depends upon the complex effects of the various imperfections relating to the market for finite resources. This analysis has shown that the current level of resource extraction could exceed the socially optimal level and that the social opportunity costs of the current consumption of a finite resource could exceed its current market price on account of some of these imperfection, such as the lack of a futures market, and the existence of uncertainty, risk aversion, myopia, capital market imperfections and externalities associated with the extraction and use of the resource. However, there are other imperfections which could have the opposite effect. In particular, the existence of monopoly in the energy market has increased energy prices and means that the current level of energy consumption may be too low (on a global, but not necessarily a national, level for all countries). At this conceptual level, it is difficult to determine the net effect of these counteracting forces. This will depend upon the relative importance of the determining factors highlighted in the analysis above.

2.2.1(iv) <u>Summary of the market imperfections</u>

Thus, there are three main types of market imperfections which could prevent private market forces from attaining the social optimum for a product such as beverage containers. These are:-

(i) a lack of consumer sovereignty;
(ii) the existence of any externalities;
(iii) the consumption of any finite resources, such as energy and raw materials, which are considered to be incorrectly priced.

Therefore, in analysing an environmental issue such as beverage containers, it is necessary to determine three points:-

(I) The existence of any of these three types of market imperfections relating to the activity under review (i.e., whether the consumers have the full information and freedom of choice required for their purchasing decisions; whether there are any externalities resulting from the activity, etc.).

(II) Whether these externalities are 'potentially relevant' externalities in that they result in the current private position for the activity under review differing from the social optimum.

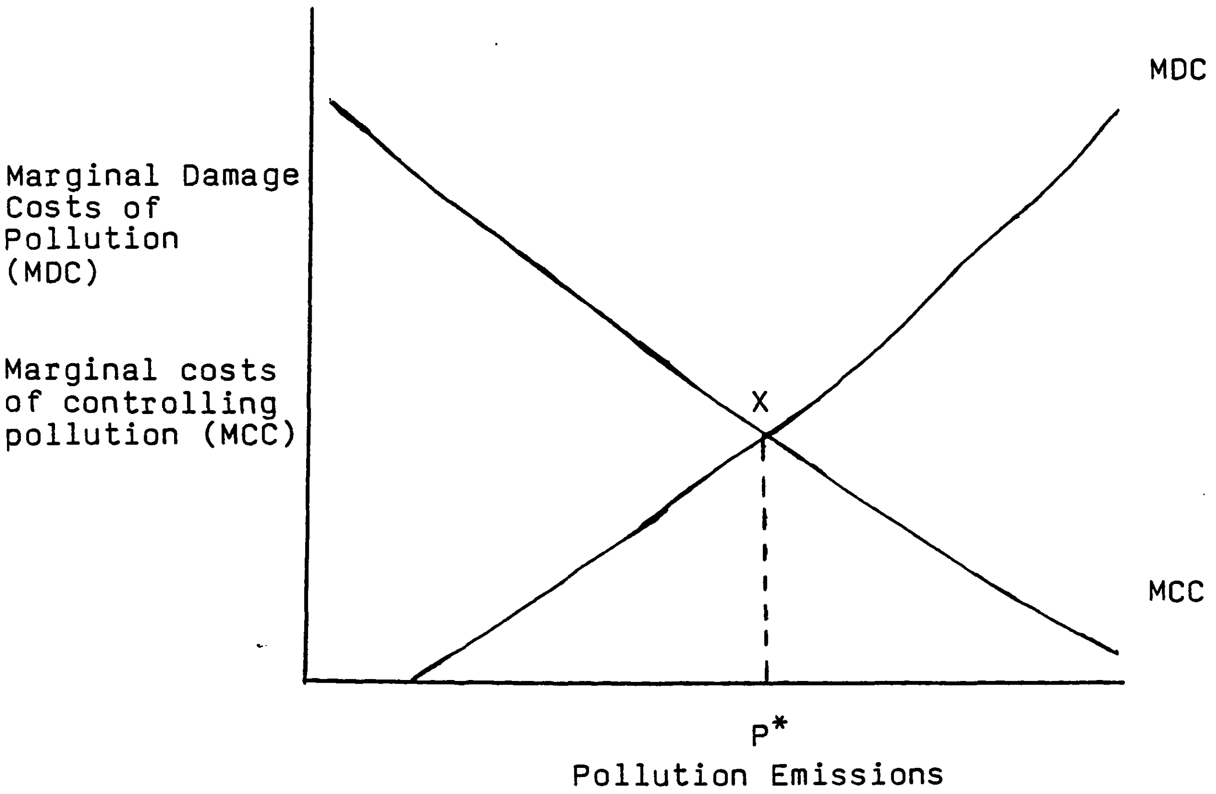
(III) The importance, or valuation, that society places (perhaps only implicitly) on these market imperfections. This determines the significance of the divergence between the current position and the social optimum for the activity under review.

2.2.2 Evaluation of policy measures for the correction of market failure

The details of a policy evaluation procedure are best demonstrated in the light of a specific case. Therefore, they are presented in the context of beverage container policy measures in Chapter 4. This section briefly reviews the general economic theory and principles concerning the selection of policies for the correction of market failure.

The economist's approach to the problem of externalities is that they should be reduced not to a minimum level (zero) but to an optimum level [e.g., see Freeman et al (1973), Beckerman (1974)]. The reason for this optimising

Figure 2.2 The optimal level of pollution control



externality generating party and the environmental protection department of the government which acts collectively on behalf of those affected by the externality. This 'collective' bargaining between the government and the externality generating party will, according to Buchanan and Stubblebine, result in the externality being reduced until there are no further 'pareto-relevant' externalities. This is similar to the general principles for environmental policy evaluation outlined earlier. Thus the externality should be reduced until the externally affected parties' valuation of the benefits of a further marginal reduction in the level of the externality is equal to the externality generating party's costs of making this marginal reduction so that overall social welfare could not be further increased. This is the optimum pollution level (p*) shown earlier in Figure 2.2.

As Nath (1969) points out, the existence of any potentially relevant externalities does not necessarily mean that the government should implement measures to eliminate these externalities on account of the possible adverse economic impacts. However, the existence of any 'Pareto-relevant' externalities does mean that measures should be undertaken to control the externality.

2.3 Conclusion

This chapter first highlights the need for developing a sound framework for examining an environmental issue. Accordingly, the second section reviews the current economic literature and develops a general conceptual framework for analysing environmental issues. This conceptual framework is based upon the premise that the government should be considering whether the current private market mechanisms are functioning efficiently - where efficiency is defined in terms of the achievement of the greatest social welfare for the whole community, or the attainment of the social optimum. This entails an assessment of whether the current position in the market differs from the social optimum. It is shown that any such divergence can be caused by the existence of any market imperfections. The analysis covers three types of market imperfections that are likely to be particularly important for an environmental issue such as beverage containers. These are: an absence of consumer sovereignty; the existence of any externalities resulting from the production, distribution and disposal of a good; and the consumption of finite resources which are incorrectly priced under the current market mechanisms. It is demonstrated that the question of whether the government should consider to intervene on a particular issue will depend upon the existence of any market imperfections and, in particular, the existence of any significant 'potentially-relevant' externalities. However, any intervention to reduce these market imperfections may have adverse economic impacts on industry and consumers. Consequently, the market imperfections should not be reduced to zero but to an optimum level where the costs of securing a further reduction in their level just exceed the social valuation of this reduction. Therefore, in order to determine the extent of any government intervention and to select the appropriate policy measure, it is necessary to assess the significance of the benefits (as represented by the reductions in the level of the externalities and the other market imperfections) and the economic impacts arising from all the alternative policy options.

CHAPTER 3

THE MEASUREMENT OF ENVIRONMENTAL DAMAGE COSTS

Introduction

It is evident from the previous chapter that the valuation of the environmental costs and benefits is of great importance in an analysis of environmental issues. Thus the social valuation of an externality determines the significance of the divergence between the social optimum and current market position and, hence, the existence and extent of any need for the government to consider any control measures. In addition, Figure 2.2 shows that it is the social valuation of the damage costs of pollution, when compared with the economic costs of reducing pollution levels, that determine the optimum level of pollution control. Facht and Opschoor (1978) point out that the economic difficulties currently experienced by many countries mean that increasing importance is being attached to any adverse economic impacts of environmental policies and that, therefore, increasingly the question is being asked "what are the benefits of these environmental policies and do they outweigh the economic impacts?[1]" Facht and Opschoor (1978 p.V2) go on to say that:

> "It is obvious that these questions need to be answered. This requires better knowledge of the costs and benefits of environmental policies. This

(1) Further recent evidence of the increasing demand for the evaluation of environmental damage costs, and hence the benefits (in terms of avoided damage) of environmental policies, can be found in OECD (1980).

is especially true for the benefits of environmental policies which, in most cases, are underestimated or even unknown. The crucial question then becomes - "what can be done to improve the data base for these decisions?".

Earlier reviews of environmental issues have been criticised for the way in which they have assessed environmental damages. Thus some writers have argued that, on account of the difficulty of defining and measuring damages to the environment, these impacts have not been adequately taken into account in the decisions [e.g., see Bohm (1972), Dorfman (1976)]. Therefore, there is a need to examine carefully how environmental costs and benefits should be valued so as to achieve a satisfactory method of including the environmental impacts as an input into the decision-making process.

- The first section of this chapter, 3.1, presents the objective behind the assessment of environmental impacts.
- Section 3.2 examines the political and economic approaches towards the attainment of this objective.
- Section 3.3 comprises a review of some of the main methods that have been adopted for the economic evaluation of environmental impacts. This effectively highlights a number of important practical problems involved in the economic evaluation of environmental impacts.
- On the basis of this information on the ideal objective and the practical problems of achieving it, the final section 3.4 then develops a possible 'best practicable' approach to the evaluation of environmental impacts.

3.1 The objective

The objective in assessing environmental impacts is to provide an input of information on the nature, magnitude and significance of the environmental impacts. This information should be designed to aid the decision-makers so that they can gain a better understanding of these impacts and, hence, be able to ascertain the importance that society (including both present and future generations) places on the environmental impacts under review.

3.2 Approaches towards the achievement of this objective

3.2.1 The political approach

Arrow and Scitovsky (1969, p.113) state that:

> "The political system is one important mechanism for the allocation of resources (dominant in a socialist system) of major importance in virtually all modern systems."

Bowen (1943) suggested that a ballot of the individual members of a community can determine the optimal decision on an environmental issue (e.g., the level of environmental services to be provided etc.). In the context of the beverage container debate, such voting procedures have been adopted in the USA, where a number of States have held referenda on whether beverage container legislation should be implemented. However, apart from being a rather cumbersome and costly procedure, referenda also have a number of other important limitations.

Portney (1975) examines the assumptions behind Bowen's analysis and finds that they do not accord with reality[2]. The turn out for such referenda is generally low and the abstainers are likely to have different

(2) The assumptions behind Bowen's analysis are detailed in Bowen (1943, p.120). A critique of these assumptions is given in Portney (1975, pp.298-300).

preferences from the voters so that the results of the vote cannot be taken as representing the socially optimal decision. Consequently, Portney (1975) and Freeman (1979a) are sceptical about the usefulness of such voting methods for assessing environmental issues[3].

Furthermore, Rowen (1975, p.309) adds that the results of a vote, and hence its ability to yield a reliable decision on an environmental issue, will depend upon the (lack of) information that the voters have on the issue and the existence of any element of bias. It is likely that the individual voters will not be fully aware of the complex ramifications involved in an environmental issue. In addition, the campaigns run by both sides may concentrate on emotive vote catching arguments, some of which may well be unfounded or exaggerated. Therefore, the electorate may not be given an informed view of the issues on which they are voting. Brandt (1975) says that this did occur in the American States' referenda on beverage container legislation. He also shows that the greater financial resources of the parties opposing legislation meant that they were able to make greater use of the advertising media during the campaign.

Portney (1975) points out that voting is of limited usefulness for the determination of new wide-ranging projects

(3) Freeman (1979a) also notes that voting could only be applicable where the costs and benefits of an environmental protection programme affect solely the voting community. Hence, this makes the use of referenda (especially local referenda) inappropriate for pollutants that cross local and national boundaries.

for which there are a number of alternative variants (e.g., plants of different sizes, types, location, etc.), since the voters are usually restricted to saying yes or no to particular propositions. This problem could be overcome if a series of iterative referenda were performed until the optimum solution concerning the type and level of project was arrived at. However, such iterative referenda would not be practicable. This means that the selection of the particular proposition and the actual phrasing of the question in the referendum can have an important effect on the outcome.

Tullock (1959) emphasises that referenda do not enable the voters to reveal the intensity of their preferences. Consequently, the use of majority voting can result in efficient[(4)] projects being rejected and inefficient projects being accepted [see Portney (1975)]. Tullock (1959) concludes that majority voting is not by any means an optimal method of allocating resources. Portney (1975) goes on to suggest that it is therefore useful to consider an alternative procedure which attains both the efficiency and equity objectives.

Bowen (1943) also points out that, in practice, the issues in elections are rarely clear cut so that the electoral system can seldom be regarded as yielding unequivocal indications of public preferences. Therefore, he also suggests that it is necessary to examine other methods of ascertaining public preferences on specific issues.

(4) Where efficiency is defined in terms of maximising social welfare.

This leads to an examination of the decision being made by a body of elected representatives who, ideally, could take into account the intensity of the public's preferences concerning the issue under review. Pressure groups are a commonly adopted means of conveying such information to the elected decision-makers. This conforms to Dorfman's (1976) definition of the 'decision-maker' as being not a single entity but rather a body that performs the process of reconciling the desires and claims of the various groups affected by the issue under review. However, certain reservations have been expressed concerning the manner in which this procedure currently operates. Thus, Freeman (1974) states that:

> "One must certainly hope that the executive branch will be responsive to the known wishes and needs of the population and will be active in trying to ascertain these needs where they are not known. But the experience of politics over several thousand years has shown conclusively that this cannot be relied upon".

Rawls (1973) advocates that the discussion in the political arena should not be seen as a contest between conflicting interests but rather as an attempt to build a consensus and formulate a 'just' policy. This may apply in the more consensus-oriented societies such as Japan and Sweden. However, in Europe and (particuarly) North America, a more adversarial attitude and approach prevails. This may push the respective pressure groups into more extreme and rigid stances. Consequently, it is open to doubt whether the views expressed by the pressure groups in the latter countries are truly representative of public opinion on the issue. Furthermore, Galbraith (1967) has observed that some of the pressure groups have a disproportionate amount of influence in the political decision-making process.

Reich (1971), in his anatomy of the corporate state, develops Galbraith's concept of countervailing power [see Galbraith (1952)] and the theory of pluralism to suggest that the public decision-making process is excessively influenced by the 'organised interests' (e.g., business and organised labour) to the detriment of the, as yet, less organised pressure groups (e.g., consumers and those in the secondary labour market). Specifically in the context of environmental issues, Dorfman (1976) says that "the dice were loaded in favour of the big battalions". By "big batallions", Dorfman presumably means the established industrial groups who have greater financial resources and better information and who understand the political system better and hence tend to be able to influence it more effectively.

Finally, Brooks (1976) argues that the present system often results in paralysis or delays in the resolution of issues. In the light of these shortcomings of the present political system, Brooks (1976, p.133) concludes that:

> "The ultimate difficulty with participatory decision processes is the lack of assurance that all the relevant interests and perspectives will be represented in a balanced way. Mobilization of a particular affected constituency may depend on accidents of leadership or of command over financial resources. Many affected groups may not even perceive that their interests are involved. Others may be young children or unborn future generations."

3.2.2 The economic approach

As a result of these problems with the political approach and a desire to provide a supplementary input of 'harder' information into the political decision-making process, attempts have been made to determine more explicitly and precisely the valuation, or importance, that society attaches to the environmental impacts. Thus Williams (1973, p.60) points out that :

> "Where complex issues are involved, we must rely on analysis to help. Intuition and goodwill alone will not help".

Mishan (1975) suggests that the valuation of environmental impacts should be based upon the allocative criteria of welfare economics. Under this economic approach, the environmental impacts are valued in terms of the individuals' 'willingness to pay' for the environmental good. There are a number of issues which should be highlighted concerning this 'willingness to pay' criterion.

First, Rawls (1973) argues that intensity of desires or convictions are irrelevant for purposes of social decisions. There may be some truth in Rawls' statement that people who express their opinions with greater conviction are not more likely to be right. However, the variation in individuals' preferences could be due not only to the greater conviction and confidence of some individuals, but also to variations in the actual impacts of a measure upon different individuals and to variations in their preferences on the issues involved. Failure to allow for the latter effects can lead to the problems concerning majority voting that were identified in the previous section [see Portney (1975)].

Second, and more importantly, the 'willingness to pay' valuations reflect not only the intensity of an individual's preferences but also his/her income. This has distributional implications which are considered later.

Third, conventional Cost-Benefit Analysis (CBA), as strictly defined, requires an evaluation of the various impacts of a policy in a commensurate unit (money). The economic evaluation of the various environmental impacts in terms of a common monetary unit would enable comparison and aggregation of the many different types of environmental impacts that are likely to be involved in a specific issue or project. Moreover, estimates of the costs of an environmental policy will usually be presented in monetary terms. Therefore, the presentation of monetary valuations of the policy's benefits would enable direct comparisons and trade offs between an environmental policy's benefits and costs and a single figure for the policy's net value could then be derived. However, it is disputed whether it is possible to derive a monetary willingness to pay figure for many environmental impacts on account of their essentially qualitative nature. It has been argued that attempts to assign monetary values to the environmental impacts of a project have led to such qualitative impacts being given insufficient consideration or being ignored altogether in the decision-making process[5].

Fourth, Nash et al (1975) raise the question of 'whose preferences shall count'? In particular, whether the preferences of future generations and children should be

(5) This subject is examined further in the final section of this chapter.

considered and, if so, whether they can be adequately taken into account? Lecomber (1978) states that the economic approach concentrates on the 'willngness to pay' of current generations. The existence of uncertainty and risk aversion and myopia on the part of current generations means that there is a positive time preference rather than the zero time preference advocated by Rawls (1973). It should be noted that Rawls does not deduce from this that a zero discount rate should be adopted but that an appropriate discount rate should be used to allow for future generations' greater wealth arising from current investments. However, the forecasts of a continuing rise in welfare levels have been disputed by some authors [e.g., Meadows et al (1972), Mesarovic and Pestel (1975)]. These doubts, along with other considerations, such as the existence of capital market imperfections, risk aversion and myopia, have prompted the suggestion that the interest rates currently used in economic evaluations could lead to insufficient weight being given to the welfare of future generations(6) [Lecomber (1979)].

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(6) However, the political approach is probably no better than the economic approach in this respect and, in fact, it may be worse since the political decision-makers concentrate on the current generation of voters and, in particular, on the voters in marginal constituencies. Furthermore, the time horizon of political decision-makers is likely to be 3-5 years (the date of the next election) and therefore they are likely to give little weight to the future welfare of the current generations let alone that of future generations [See the quotation from Brooks (1976) given earlier on page 67].

Fifth, Nash et al (1975) question whether the economic approach's concentration on the values revealed by individuals' preferences is appropriate in all circumstances. This concerns two aspects. One applies in situations where, on account of lack of information, the individual consumer cannot fully perceive a particular impact. This aspect covers 'merit' goods (e.g., health, education), de-merit goods (smoking, safety belts, crash helmets) and also environmental impacts that are outside the individual's normal perceived horizons (e.g., long-run cumulative health impacts, impacts on distant parties). Nash et al (1975) argue that decisions on such goods and impacts should not be based solely on the individuals' preferences and willingness to pay but should also take into account those aspects that are not perceived by the individual consumers. The second and related aspect concerns the economic approach's consideration of the benefits of an environmental policy solely in terms of the effects upon the economic welfare of mankind. Thus impacts on the natural ecosystem are only included in the valuation in so far as they affect mankind's economic welfare. This humanistic approach means that, in an analysis, no intrinsic value would be attached to the extinction or preservation of a species. Tribe (1976) presents an interesting critique of these humanistic foundations of economic evaluations. This latter aspect is related to the former one to the extent that the extinction of a species or a reduction in genetic diversity may appear at present not to have any adverse impacts on humans while, in fact, it might have some (as yet unperceived) impacts on human activity in the future.

The aggregation of individuals' preferences

The use of the CV vs EV concept

The efficiency criterion of welfare economics is the Hicks-Kaldor test of potential pareto improvement. [Hicks (1939), Kaldor (1939)][7].

Under this criterion, a policy is deemed to secure a (potential) pareto improvement if the sum that the beneficiaries are 'willing to pay' for a policy to be implemented exceeds that which the losers are 'willing to receive' (in compensation) for the costs arising from the implementation of the policy - i.e., if the beneficiaries could 'over'-compensate the losers. The objective of this economic approach is to maximise this measure of social welfare. Therefore, this procedure is designed to lead to the selection of that policy which yields the maximum surplus of benefits over costs. However, Mishan (1975) criticises the use of this Compensating Variation (CV) concept and suggests that an Equivalent Variation concept (EV) should be used as a supplement or an alternative to the CV concept. This EV measure considers what consumers would be 'willing to receive or pay' if the policy or project was not implemented. Under this alternative concept, a policy should be introduced if the sum that the beneficiaries are willing

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(7) A more detailed analysis of the conceptual foundations and problems of this economic approach is given in Mishan (1975), Nash et al (1975) and Freeman (1979a).

to receive to forgo the policy exceeds that which the losers are willing to pay to prevent its implementation.

Mishan (1975) shows that the sum that beneficiaries are willing to pay is less than the sum they would be willing to receive. The former sum being constrained by their income. This intuitive reasoning is supported by recent empirical information [see Pearce and Edwards (1979)]. Therefore, Mishan (1975) demonstrates that the introduction of a policy measure for environmental improvement could be considered to be undesireable under the Compensating Variation concept, while at the same time the failure to introduce this policy could also be incorrect under the Equivalent Variation Concept(8). In this respect, Mishan emphasises the role of the currently accepted law of legal liability in determining the outcome. He argues that an implicit favouring of the status quo results from the lack of any legal property rights in a clean environment and the pareto-potential basis of conventional Cost-Benefit Analysis, which entails the use of the CV concept(9).

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(8) However, a policy or project that resulted in a deterioration in the environment could be considered undesirable under the CV concept while this project could be acceptable under the EV concept. Therefore the use of the CV rather than the EV concept is not inherently pro- or anti-environment. Nevertheless, it favours the status quo and means that insufficient environmental improvement measures would be undertaken.

(9) In relation to current environmental policies in general, and the beverage container issue in particular, Mishan's statement may still have some relevance today. Thus the onus is on the advocates for environmental improvement to demonstrate that an environmental issue is sufficiently important to warrant investigation and then that the environmental benefits outweigh the administrative costs and economic impacts of intervention. (contd. next page)

Efficiency/equity objectives

Haveman and Weisbrod (1975, p.38) state that:

> "Concern with the goal of allocative efficiency is the preoccupation - indeed the sole concern - of the 'new welfare economics' and, at least until recently, of cost-benefit analysis."

Thus cost-benefit analysis, as strictly defined and applied, does not give any explicit treatment of the distributional implications of a project. This developed from the attempt to obtain value free analytical tools, which would enable the analyst to avoid the problem of having to incorporate in the analysis his - or some other persons' - value judgements on the normative issue of equity.

However, a closer inspection of the application of this strictly defined cost-benefit analysis reveals that it does entail some implicit value judgements concerning equity. First, the economic evaluation is based on the preferences of individuals as represented by their 'willingness to pay', which are affected by their incomes so that greater weight is thereby given to the higher income

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(9) (contd. from previous page) During the 1970s, the balance may have been redressed somewhat in favour of the environment as a result of certain legislation and (international) recommendations [e.g., the Polluter-Pays Principle, OECD (1972)] and, of particular relevance to this study, the passing of the OECD recommendations concerning beverage containers [see OECD (1978)]. These directives meant that there was then pressure on the industrial bodies to demonstrate that some policy measure for environmental improvement should not be implemented. The current adverse economic conditions mean that the onus of proof has now moved back on to the environmental bodies to demonstrate that an environmental problem is sufficiently important to justify action.

groups. The use of this criterion implies that the marginal utility of income is deemed to be constant for all individuals and that the current distribution of income is optimal. This latter aspect is also important since the current distribution of income affects the relative market prices upon which the efficiency results of the economic approach are based. Thus Haveman and Weisbrod (1975, p.46) conclude that:

> "As a consequence, judgements about desirability or acceptability of alternative income distributional patterns are conceptually inseparable from estimates of social benefits."

Second, the potential pareto improvement test of conventional Cost-Benefit Analysis entails only hypothetical compensation. It does not necessarily involve actual compensation of the losers by the beneficiaries. This detracts from the analytical niceties of the economically efficient solution. Thus Haveman and Weisbrod (1975) argue that an 'efficient' project, which passes the potential pareto improvement test, does not unambiguously increase social welfare unless the compensation is actually paid. They go on to point out that the payment of the compensation would be difficult and also that the approval of a project by the political decision-makers can depend significantly upon whether or not compensation is paid. Therefore, Haveman and Weisbrod (1975, p.42) advocate that:-

> "In short, an explicit decision regarding the desirability of the income redistributional effects is required before a meaningful statement can be made about the effect of net benefits on real welfare."

The importance of distributional issues to decision-makers and the need to go beyond the efficiency criterion and give explicit consideration to distributional impacts are further borne out by various other authors [e.g., see Rawls (1973), Portney (1975), Rowen (1975)].

Portney (1975) points out that the distributional anonymity of conventional Cost-Benefit Analysis may well have been one of the reasons for political decision-making procedures, such as referenda, being used instead.

Therefore, a number of methods have been proposed for the explicit incorporation of distributional considerations into the analysis. These include: Little's proposal that a project should have to pass not only the Hicks-Kaldor test but also that it must improve the distribution of income [Little (1957)]; Rawls' maxi-min criterion [Rawls (1973)]; the proposal that the results of a cost-benefit analysis should be presented in a disaggregated format so that the incidence of a project on various income groups can be readily identified [e.g., see Nash et al (1975)]; and some authors have used information on past government decisions (e.g., marginal income tax schedules or government expenditures) to derive a set of implied social distributional weights which can then be used with the disaggregated incidence data to determine a project's impacts on 'social welfare' [e.g., see Krutilla and Eckstein (1958), Haveman (1965), Weisbrod (1968)]. The various proposals do also have some limitations and have been subjected to criticism. In particular, Nash et al (1975) are sceptical of the techniques that derive distributional weights from government decisions.

3.3 Methods adopted to value environmental impacts - Practical problems encountered

The need for more substantive information to aid the political decision-makers' consideration of an environmental issue has meant that a number of methods have been adopted to assess environmental impacts. These methods include: physical impact studies; consumer surveys; market based studies; house price depreciation - or hedonic pricing - studies; travel costs models; and the use of the assessments of experts and the official authorities. In their application, some important practical difficulties have been encountered which effectively highlight the complex problems of valuing environmental impacts.

3.3.1 Physical measures of pollution damage

Physical measures are a fundamental building block for the economic evaluation of pollution damage. However, there is a lack of data on the levels of pollutants in the environment and on the various physical indicators of environmental quality.

Walters (1975) reviews the various possible measures for noise and shows that there is some controversy over which of these measures gives the best index for the disturbance caused by aircraft noise.

Turner (1977) shows that there are a number of alternative indicators of water quality that are relevant for different aspects of recreation. He points out that water quality measures are often selected more on the pragmatic basis of whether hard scientific data are available to enable their use in practice rather than whether they give a theoretically perfect indicator of the perceived impact of the pollution upon consumers.

In addition, there is insufficient knowledge about the effects of a pollutant on the ecosystem and the physical impacts of environmental changes on humans (e.g., effects on morbidity and mortality rates). Multiple regression analyses, episodic, epidemiological and laboratory studies have been undertaken to develop some dose-response relationships for the effects of pollutants on humans(10). However, there is much controversy over the different studies' results. Furthermore, most of these studies relate to the United States and may not be appropriate for other areas where the conditions are different. Differences in the metereological and topographical conditions may lead to differences in the ambient concentration levels of a pollutant in the environment and the physical damages of a pollutant will be greater at higher ambient concentration levels. In addition, the physical impacts of the pollutant will be affected by variations in the type and number of plant and human life and also the levels of other pollutants in the affected area. Therefore it is ideally necessary to

(10) Further details on the methods, results and limitations of such studies are given in Lave and Seskin (1977), Freeman (1979a,b), OECD (1983).

undertake a specific physical impact study for each particular situation or, if this is not feasible, to exercise considerable caution in applying the results of other studies to a different situation.

Consequently, there is a need for more and better information on the physical damage functions for the pollutant(s). Thus Freeman (1979a) states that the current lack of knowledge on these physical relationships may, in some cases, be a major barrier to the economic evaluation of environmental damages. Pearce (1976b, p.7) points out that:

> "While the literature on dose-response relationships is immense, it remains the case that, almost without exception, we know little of the exact linkages between pollution and physical response....... Accordingly, there is every argument for improving the state of our physical knowledge."

3.3.2 Consumer surveys

Surveys of consumers' preferences provide a potentially useful and direct way of ascertaining the value that society places upon an environmental issue. Therefore, consumer survey techniques have been extensively studied and adopted [e.g., see Randall et al (1974), Brookshire et al (1976), Brookshire et al (1979), Rowe et al (1980)].

The surveys can take the form of questions requiring a straightforward yes/no reply. However, such questions can limit the options on which the consumer is able to state his preference and do not reveal the intensity of the consumers' preferences. Therefore, some surveys have also incorporated a scale of weights for the consumers' preferences or a ranking of their preferences for the environmental impacts in question in relation to other issues. In accordance with the economic approach outlined earlier, some surveys have also attempted to ascertain directly the consumers' willingness to pay.

However, the performance of consumer surveys can raise a number of problems. Two axioms of economic theory relating to consumer sovereignty are that consumers have well defined preferences and that they have the necessary information on which to form these preferences. However, many consumers may not have predetermined preferences concerning the environmental issue in question. Furthermore, it is doubtful whether all of the consumers surveyed have sufficient information to be able to comprehend the environmental issue (and all its ramifications) which may lie outside their normal perceived horizons. Hence, many of the questions may appear hypothetical. Therefore, the consumers may find it difficult to give an answer. It is particularly doubtful whether consumers are able or willing to conceive and state a monetary sum that they are - or would be - 'willing to pay' for the environmental impacts under review. Consumers resent being asked to give a monetary willingness to pay figure for an environmental issue (e.g., freedom from noise) which they regard as a 'natural right'. Consequently, many consumers refuse to answer such questions [see Ollerhead (1973), Pearce and Edwards (1979), SEDES (1980), OECD (1983)].

Freeman (1979a) has emphasized the importance of designing a survey so as to ensure that consumers participate in the survey and provide accurate information. Randall et al (1974) also stated that the questions included in their survey had to be restricted on account of the consumers' limited patience and desire to participate in surveys.

Moreover, there are five factors that can limit the accuracy and relevance of the consumers' replies to the questions, and can create problems for the interpretation of the results generated by the surveys. The first factor is the need to ensure that the survey is just picking up the respondents' preferences concerning the environmental issue under review and not some other aspect. Thus Randall et al (1974) note that the valuations given by respondents may be affected by, and hence reflect their attitudes towards, the method of payment postulated in the survey (e.g., an aversion to paying taxes). The second concerns the importance of ascertaining how the respondent has interpreted the question so as to ensure that any possible biases can be identified and allowed for. The respondents' problems over understanding the (hypothetical) questions can lead to their misinterpreting these questions and hence giving inaccurate and inconsistent replies. Ridker (1967) cites an instance where this occurred. The questions in some studies contain certain ambiguities. Thus Mishan (1970) criticses the Roskill Commission's use of questions about the consumers' valuation of the compensation required if they had to move to another area, on the grounds that the extent of the move was not specified. In one study [Langdon (1978)], the questions were deliberately phrased ambiguously in terms of 'what it is worth' to reduce traffic noise. This was considered to be neutral between the compensation and willingness to pay approaches and was designed to avoid the problem of resentment and non-response to questions concerning natural rights. However, this procedure is still subject to the problem of 'how neutral' were the questions? and how were they interpreted by the respondents?

A third and important factor is the identification of the level and the particular characteristics of the environmental impacts that the respondents are valuing. This problem is exacerbated by the subjective nature of individuals' perceptions of environmental impacts.

Fourth, the consumers are likely to be biased by the information given during the interview and by the manner in which the question is phrased. Thayer (1981) reports that a study by Rowe et al (1980) revealed that the information given has a significant effect upon the valuations expressed by respondents. Freeman (1979a) comments that surveys, which derive willingness to pay estimates by a series of iterative questions of whether a certain value is too high or too low, are subject to the problem of starting point bias. However, Thayer (1981) found no evidence of any starting point bias in his study.

The fifth possible limitation of consumer surveys concerns the problem of strategic answering to questions about willingness to pay (WTP) on the part of consumers acting as 'free riders' in the collective decision on the project [see Samuelson (1954), Bohm (1972)]. Thus, if these 'free rider' consumers thought that they would have to pay a sum equal to their WTP figure, then this introduces an incentive for them to understate their willingness to pay. While, if they think that they personally might not have to pay the costs of the (local) project which, for example, might be borne by national taxpayers, then there may be a tendency for them to overstate their preferences. The direction and significance of this bias will depend upon the source from which the project will be financed, the respondents' impression on this matter and the effect that this has on their replies. In relation to this point, the survey should be attempting to ascertain the consumers' willingness to pay for the project <u>independently</u> of the financing of the project. When the final decision is made on the project, the summary WTP figure will be compared with the costs and the methods of financing the project. Therefore, the information and questions in the survey should be designed and presented to ensure that the consumers only consider the benefits aspects and give a WTP figure that is independent of the financing of the project.

Thayer (1981) reviews the recent evidence concerning the problem of strategic answering and concludes that strategic behaviour can be avoided by sound questionnaire design and that significant problems of strategic answering do not appear to have been encountered in recent studies.

It is apparent that this limitation and also the other limitations could satisfactorily be overcome by improvements in the design and execution of the survey.(11)

For example, more elaborate consumer survey techniques have been developed which incorporate the use of visual aids to provide the respondent with more information and a more realistic awareness of the subjects on which they are being questioned [e.g., see Hoinville (1971, 1975)]. The survey is designed so that the respondent plays it as a game and the questionnaire is framed in an iterative manner. In this way, the survey elicits the consumers' opinions and preferences on the actual issues under review. In some studies [e.g., Hoinville (1971)], monetary willingness to pay values have been derived from the consumers' relative preferences for the environmental benefit in comparison with an item with a monetary dimension (e.g., savings in journey costs, fares, etc.). Furthermore, consumer surveys have been extensively used recently in the 'bidding games' studies which have been performed for major environmental impacts and issues (e.g. see Brookshire et al (1976, 1979), Thayer (1981)).

It appears that, where the main possible pitfalls and limitations highlighted earlier are overcome through a sound organisation and performance of the survey, then such

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(11) However, it is important to note the possible conflicts that could arise from the resolution of the various limitations. For example, the provision of more information could reduce the hypothetical nature of the questions but, unless this information was carefully presented, it could bias the respondent.

thorough consumer surveys could provide the most valuable of the various methods of valuing environmental impacts. Thus Pearce and Edwards (1979, p. 217) conclude that: -

> "Direct questions about 'Willingness to Pay' are possible, and while there are numerous problems to overcome, it seems more likely that useable results will emerge from surveys rather than from models with theoretically unsound bases".

Nevertheless, these more elaborate techniques are still subject to and in fact exacerbate one final and important problem with consumer surveys. This is the costs involved in undertaking sufficient in-depth individual interviews to ensure that the survey can yield representative and valid results. In many cases, a lack of resources may preclude the possibility of adopting this potentially valuable technique.

3.3.3 Market Based Studies

Estimates of consumers' valuation of an environmental good could be derived from studies of market behaviour. This is based upon the premise that consumers' actual expenditures reveal their preferences and that "Actions speak louder and clearer than words". Thus consumers' expenditures on measures to reduce the impact upon them of an environmental problem could be expected to yield a (minimum) estimate for their valuation of the environmental problem. Prominent examples of abatement expenditures are the installation of double-glazing and the cleaning/ repainting of materials and buildings.

However, there are five major problems with the market based approach. Firstly, reduction of the impact of the environmental pollutant may not be the sole function of the abatement expenditure. Thus double-glazing may be installed to cut heating costs as well as to reduce the impact of traffic noise. This limits the ability of abatement expenditures to give useful measures of the valuation of a particular environmental problem.

Secondly, the householders' abatement activity may not be a perfect substitute for the absence of an environmental problem and may not perfectly restore their welfare to the level of the original polluted situation. For instance, the installation of double glazing may reduce the level of the noise inside the house but will still mean that the householder suffers the unabated noise levels when he opens the window or sits in the garden. Thus there will still be residual impacts which must also be taken into account.

A third problem arises since the consumers' expenditure on abatement techniques may only represent a <u>minimum</u> estimate of their willingness to pay for a reduction in an environmental problem on account of the existence of any consumers' surplus element which should also be included.

Fourthly, the ability of householders to install the abatement equipment may be limited by various factors, in particular their income. Consequently, market based measures will be reflecting ability to pay as well as willingness to pay so that their use raises some distributional problems.

The fifth problem concerns the limited capability of the market-based approach to provide a valuation of certain environmental impacts where the consumers do not have full information on the nature and extent of the environmental problem and where there is a lack of interaction between the demand for an environmental good and the market demand for private goods. In these circumstances, there is not a marketable commodity which can represent a surrogate indicator for the environmental impacts. Thus, Freeman (1979a) states that valuations of non-user environmental benefits, such as option value, preservation value, etc., cannot be inferred from market-based studies.

Moreover, Ridker (1967) and Peskin and Seskin (1975) point out that, in practice, it is difficult to obtain good data on abatement expenditures, especially those undertaken by households, let alone to be able to separate and single out the effect of pollution from the other determinants of abatement expenditures.

Ridker (1967) indicates that this latter aspect would entail the performance of an opinion survey of householders which would have to include sophisticated questions about their abatement expenditures and which would require considerable time and money. Peskin and Seskin (1975, p.12) conclude that:-

> "However, the analyst should be aware of a practical difficulty with this approach. Identifying those expenditures which are truly defensive is seldom an easy task. For example, to determine the extent to which home air conditioning represents a defense against polluted air versus a defence against humidity and high temperatures would require knowledge about the motives behind each purchase of an air conditioner. Unfortunately this type of information is rarely available to the analyst."

Ridker (1967) also reports the results of inter- and intra-urban studies which revealed no positive correlation between air pollution levels and cleaning expenditures. There are four possible conclusions that can be drawn from this finding. First, that the pollution does not have any effect upon the welfare of the householders. Second, that abatement expenditures are poor indicators of the impact of pollution on householders' welfare. Third, that the abatement expenditure studies have some important deficiencies and limitations. A fourth possible conclusion is that the elasticity of demand for cleanliness is equal to unity. This aspect was raised by Watson and Jaksch (1982) who show that the effects of an improvement in air quality on cleaning expenditures depend upon the size of the elasticity of demand for cleanliness and that changes in cleaning expenditure would only provide an accurate valuation if the elasticity of demand is zero. They suggest that the elasticity of demand is close to unity so that changes in cleaning expenditures would underestimate the benefits of an improvement in air quality[12].

It appeared, in Ridker's study, that other determinants of cleaning expenditure levels (e.g., the desire for uniform cleaning schedules) outweighed any effect of the soiling damages caused by the emission of air pollutants. This gives some support to the first hypothesis and possibly also the second. However, other studies found that cleaning

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(12) A detailed examination of Watson and Jaksch's analysis is given in Freeman (1979b) and OECD (1983).

costs for households were higher in more polluted areas [e.g., Michelson and Tourin (1966), Liu and Yu (1976), Heinz (1979)]. Furthermore, consumer surveys have found that consumers did desire improvements in environmental conditions and that they were willing to pay for these improvements [e.g., see Hoinville (1971), Brookshire et al (1979)]. These and other observations of householders' dis-preferences for pollution run counter to the first hypothesis and suggest that the second and third hypotheses require detailed examination. These issues are now considered in the context of one market based valuation technique that has received extensive study: the house price depreciation or Hedonic pricing approach.

3.3.4 The house price depreciation - or hedonic pricing - studies

Hedonic pricing is an established technique that has been used for the valuation not only of environmental impacts, such as air pollution and noise, but also of other social issues, such as workers' health and safety [e.g., see, Thaler and Rosen (1976)].

The general theoretical foundations of hedonic pricing have been formulated elsewhere [e.g., see Rosen (1974)], as has the application of these theoretical foundations to environmental issues [e.g., see Harrison and Rubinfeld (1978b), Freeman (1979c), Pearce and Edwards (1979)]. The various empirical studies have been extensively reviewed in other reports [e.g., see Walters (1975), Pearce (1978), Freeman (1979a), OECD (1983)]. Therefore, these theoretical foundations and the details of these studies are not examined in depth in this thesis, which first outlines the theory of hedonic pricing as applied to environmental issues, such as noise and air pollution. The major assumptions behind this technique are then critically analysed.

Hedonic pricing: Theory and Underlying Principles

Under this approach, house prices are considered as being determined by their characteristics, one of which will be the quality of the house's environment (e.g., the noise level, etc.). In this case, the consumers' abatement activity is moving from noisy to quiet areas. Such movement will result, ceteris paribus, in higher prices for the quieter houses. Therefore, analysis of the prices of houses in areas with different pollution levels should enable derivation of an estimate for householders' willingness to pay for environmental quality improvements.

The hedonic pricing technique involves four sequential steps. These are:-

- Step 1 comprises the formulation of the hedonic house price function. This function includes various characteristics of a house that determine house prices.
- Step 2 consists of calculating the derivative of the hedonic house price function with respect to the environmental attribute (e.g., level of noise). This derivative represents an estimate of the household's willingness to pay for a marginal environmental improvement. This is also sometimes referred to as the marginal implicit price of the attribute.

- Step 3 entails the estimation of the marginal willingness to pay function of households. This function is analagous to a demand curve for a clean environment. The function is determined by regressing the households' marginal valuations (the derivatives calculated under the second step) on the level of noise and other variables (e.g., household income) which are parameters of the demand curve for a clean environment.
- Under the final Step 4, the benefits of an environmental protection programme are then calculated by inserting into the willingness to pay function the appropriate environmental quality levels before and after the programme and estimating the corresponding area under the demand curve.

Critical analysis of the hedonic pricing technique

There is a wide divergence between the results that the different studies at individual sites give for the depreciation in house prices with a unit increase in the noise level [see Pearce and Edwards (1979)]. This indicates that the results from a particular study of one specific situation may not necessarily be applicable to another situation. Therefore a specific study (ideally) should be undertaken for each individual situation.

However, the performance of a multiple regression house price study raises a number of theoretical and empirical problems which should be overcome if a hedonic or house price study is to yield meaningful results. The following critical analysis is designed to identify the major potential problems associated with the hedonic price models.

(a) Assumption of a perfect housing market in equilibrium

The hedonic price models assume that there is a perfect housing market and that it is in equilibrium. However, Pearce and Edwards (1979, p.211) comment that:

> "of all markets, the housing market is the one in which such an assumption is least likely to be met."

If these two assumptions do not hold, then the actual market prices of houses do not equal the householders' desired prices and a change in a house's characteristics will not necessarily be (immediately) reflected in a change in house prices. Maclennan (1977) states that this possible existence of dynamic disequilibrium in the housing market means that the underlying principle of hedonic pricing theory must be questioned.

Existence of imperfections in the housing market

There are three main imperfections associated with the housing market.

(i) Lack of choice. Freeman (1979c) notes that, for certain categories of households, there are not available for sale a wide variety of differentiated houses with the appropriate mix of characteristics. This problem of the thin market would be compounded where market segmentation is evident so that separate hedonic price studies have to be performed for the specific sub-markets.

(ii) Lack of freedom of movement. There are substantial financial and psychic costs of moving houses which mean that, if there is an increase in noise levels, there will be some noise averse households who are not able to move but whose valuation (especially under an

EV measure) of the annoyance caused by the noise exceeds the house price depreciation for noise given by the hedonic pricing models [Paul (1971), Mäler (1977), Pearce (1978)].

(iii) Imperfect information. It is unlikely that prospective house purchasers will have perfect information on the diverse characteristics of individual houses, on account of the complexity of the housing market and the problems for the purchaser of perceiving certain characteristics. Mäler (1977) states that such imperfect information will result in the housing market not being in equilibrium. Nevertheless, Maclennan (1977) notes that imperfect information will only yield systematic biases in the marginal implicit prices generated by the hedonic models if the degree of imperfection of information is correlated with some particular attributes. Such correlation is likely since the potential purchaser will probably be better informed about readily discernible characteristics (e.g. size of rooms, state of paintwork) than other aspects, such as the existence of dry rot and the level of traffic noise in the night or early morning, whose presence and nature may only become evident once the purchaser has bought the house and moved in.

(b) Study of single vs. segmented housing market

Most of the empirical house price studies have had to be aggregative studies of a single housing market[13]. However, following the work of Strazheim (1974, 1975), Maclennan (1977) argues that the housing market is segmented

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(13) Exceptions to this are the studies by Harrison and Rubinfeld (1978a) and Nelson (1978a).

with respect to geographical area, type of house and type of resident. This is due to the spatial dispersion of housing, the multi-dimensional nature of housing, variations between different individual's or socio-economic group's tastes, time preferences, expectations and attitudes to risk and uncertainty, and the creation or reinforcing of barriers in the housing market by institutions (e.g., the building societies' discrimination in giving loans to certain types of purchasers or for certain types of houses in specific areas). The existence of market segmentation means that in fact there are a number of separate hedonic price functions for each segment. Consequently, Maclennan (1977) states that the aggregative house price studies will provide incorrect estimates of the implicit prices. Freeman (1979c) concludes that market segmentation is an important question which requires careful investigation and Maclennan (1977) stresses the need to perform separate analyses for each segment of the housing market. However, this raises considerable empirical problems in respect of the availability of sufficient data and the current lack of knowledge on this subject. Thus Maclennan (1977, p.70) concludes that:-

> "In general, the above critique has suggested that existing house price studies have been overaggregative.... The work of Strazheim has clearly sounded the death knell of aggregative house price studies - submarkets and subgroups have to be identified. Research is required into how individuals and institutions segment the housing market."

(c) <u>Specification of variables in the housing price function</u>

Hedonic pricing theory assumes that all important characteristics are included and are correctly specified in the housing price function and that the householders' perceptions (but not valuations) of each characteristic are identical. If an important characteristic is omitted, then the estimates given for implicit prices of the other characteristics in the model could be biased.

There are many interrelated factors that determine house prices. Mäler (1977) showed that the need to include many explanatory variables in the model would present considerable difficulties for the empirical analysis. Maclennan (1977) highlights the current lack of knowledge about how the complex housing market operates and emphasises the importance of the need for such information to overcome the problems of multi-colinearity and to enable a sound interpretation of the studies' results.

Maclennan (1977) goes on to point out that important characteristics have been omitted from the models used in some studies. It is also apparent that the results generated by the various house price studies are sensitive to the manner in which the housing price function is specified [e.g., see Anderson and Crocker (1971), Harrison and Rubinfeld (1978a), Pearce and Edwards (1979)]. Polinsky and Rubinfield (1977) emphasize the need for careful specification of the models used in house price studies. However, Freeman (1979c, p.169) points out that the present selection and specification of the explanatory variables appears to be almost haphazard and is guided primarily by convenience and data availability.

(d) Measurement of the characteristics of houses and locations

Maclennan (1977) comments that the quantitative measures of houses' characteristics, adopted in the studies, may not be an accurate indicator of the location's attrributes and can fail to reflect adequately differences in the quality of a characteristic on account of the difficulty of categorising and measuring such variations.

(e) Measurement of property values

Estimates of house prices are generally used as the dependent variable in the regression equations. However, Pearce (1978) and Freeman (1979a) note that the value of the site, rather than the price of the house, should ideally be used since air pollution and noise is site specific and the price of a house also reflects the structural changes that have been undertaken. Furthermore, in relation to noise abatement activities such as the installation of double glazing, these structural changes could raise the price of a house on account of the other benefits of double glazing (e.g., energy savings), so that the difference between the price of houses in noisy and quiet areas could fail to reflect adequately the impacts of noise. This problem could be overcome if this and all the other important structural characteristics of a house were appropriately included in the house price function. However, this is difficult to achieve in practice.

(f) The householder's utility function

The basic hedonic pricing model assumes that all householders have identical utility functions and that these functions are linear and separable. Pearce and Edwards (1979) state that these restrictive and unrealistic assumptions are the most serious limitation of the hedonic pricing technique.

(i) Linearity of the utility functions. If the householder's utility function is linear, then the coefficients from a multiple regression will equal the implicit prices for the various characteristics. However, Rosen (1974) and Harrison and Rubinfeld (1978b) doubt whether the utility function is linear. Harrison and Rubinfeld (1978b) found that the use of a non-linear utility function in the model provided a better fit than the linear function and also that the failure to allow for non-linearity resulted in a substantial overestimation of the benefits of the pollution control programme reviewed in their study. Nelson (1976) also suggested that the utility function should take a non-linear multiplicative form. In this case, the coefficients are the elasticity of demand for the various characteristics and the implicit price of a characteristic is a function of the price of the house and the level of this characteristic. This makes the analysis more complicated.

(ii) Identical utility functions. This assumption is important for the estimation of the willingness to pay function of the households in step 3 of the hedonic pricing analysis. Pearce and Edwards (1979) state that if all individuals do not have identical utility functions, then the regressions will yield a series of single observations on many different functions while the derivation of the demand curve for a clean environment requires that many observations on a single function be obtained. Freeman (1979c) refines the discussion by stating that in order to derive the demand curve for a clean environment, it is necessary to assume that all households studied have utility functions that are the same, except for those variables which are controlled for in the regression equation formed in step 3 of the analysis. Therefore the validity of this assumption will depend upon the extent to which all of the appropriate taste variables that could affect households' demand for a clean environment, have been included and properly specified in this regression equation.

(iii) Specification of the regression equation in Step 3. The initial house price studies [e.g., Ridker and Henning (1967)] did not perform the analysis in Step 3. This is tantamount to assuming that the households' marginal willingness to pay is constant over different levels of pollution or that the analysis is restricted to examining just marginal changes in pollution levels. However, in most cases, the environmental improvements studied are distinctly non-marginal [e.g. see Freeman (1979b), OECD (1983)]. Harrison and Rubinfeld (1978b) argue that it is more plausible that the marginal willingness to pay function is not constant and they show that this alternative formulation yields a lower figure for the benefits of a pollution control programme. Therefore, a limited number of studies [e.g., see Nelson (1978b), Harrison and Rubinfeld (1978a)] have attempted to estimate the willingness to pay function. In both of these cases, household income was the only taste variable included in their analyses. Freeman (1979c) suggests that the lack of other control variables might explain an apparent anomaly in Harrison and Rubinfeld's (1978a) results.

(iv) Separability of the utility functions. The studies adopt the simplifying assumption of strong separability which means that the implicit price of an attribute is not dependent on any other variables affecting house prices. However, if the utility function is not separable, then the other related variables have to be included in the regression equation used for the derivation of the willingness to pay function. This complicates the analysis. Pearce and Edwards (1979) argue that, in practice, it is unlikely that the utility functions are separable, although Freeman (1979c) argues that many interrelationships and cross-price effects are not signifcant and hence can be ignored.

(g) The supply of house-related characteristics

The house price studies conventionally assume that the supply of environmental quality is perfectly inelastic and exogenous so that the hedonic implicit prices for environmental quality are thereby only determined by and reflect demand aspects. This enables computation of the demand curve for a clean environment in the manner shown earlier in the description of Step 3 (see page 91). Freeman (1979c) shows that the supply mechanism affecting the implicit price of environmental quality is the number of houses with a specific level of environmental quality and that this could be increased by an improvement in environmental quality or by increasing the number of houses available in the area with the specific level of environmental quality. Freeman (1979c), along with Maclennan (1977), Nelson (1978b), Pearce and Edwards (1979), suggest that the supply of housing is somewhat elastic and that the supply of houses with certain levels of environmental quality is responsive to households' implicit price for environmental quality, although Maclennan (1977) also emphasizes the lack of knowledge about the housing supply function. If the supply of environmental quality is not inelastic, then the hedonic implicit prices merely represent points of intersection of the demand and supply functions. This raises an econometric identification problem and requires the simultaneous solution of the supply and demand equations for the implicit prices of environmental quality [see Rosen (1974)].

(h) Partial vs. general equilibrium models

The standard analyses in the house price studies are essentially partial. Mäler (1977) shows that if the supply of environmental quality is endogenous and affects the price of other factors and goods as well as housing, then the analysis of house prices will no longer reflect accurately the total impacts of the different environmental quality levels. In this case, he suggests that a general equilibrium analysis of the whole model is required. Polinsky and Rubinfeld (1977) state that changes in environmental quality will affect both the wage rates and transportation cost schedules and they go on to demonstrate the complexities and difficulties involved in performing an overall general equilibrium analysis.

(i) Measurement of pollution

The ideal measure of pollution is the individual householder's perception of his total exposure throughout his lifetime to the pollutant under review. However, it is not clear what is the best measure of a pollutant on account of the subjective nature of its perception by an individual. It is also possible that the perception of a pollutant will vary between different individuals. This runs counter to one of the assumptions behind the formulation of the housing price functions in hedonic models, mentioned earlier in section (c).

It is evident that, in practice, the choice of the pollution measures used in the various studies is determined by the data that is available and, in many cases, the available data has some limitations.

Freeman (1979a,b) states that there will probably be only one measurement station per city and its limited range and efficiency means that the spatially and temporally aggregated pollution readings from this station may not reflect adequately the exposure to the pollutants of the specific households that it is desired to study. Some studies [e.g., Peckham (1970), Nelson (1978a)] have had to use pollution readings over short periods. Ridker and Henning (1967) were forced to drop from their model a measure of an important pollutant - total suspended particulates - because the stations used a measure of small particulates which did not give an appropriate indicator of the perceived soiling damages to households caused by particulate matter. Freeman (1979a) also reports that few house price studies have included photochemical oxidants (smog) in the analysis on account of the lack of good data on the spatial distribution of oxidants over urban areas. Many studies use pollution readings that post-date the data on house prices [e.g., Ridker and Henning (1967), Peckam (1970), Anderson and Crocker (1971), Polinsky and Rubinfeld (1977), Nelson (1978a)].

Freeman (1979a) reports that some studies have used pollution data derived from dispersion models [e.g., Harrison and Macdonald (1974), Harrison and Rubinfeld (1978a), Smith (1978)], but he questions the accuracy of the present dispersion modelling techniques.

Anderson and Crocker (1971) state that the two pollutants most commonly examined in the house price studies - total suspended particulates and sulphur oxides - are highly correlated and also that the damages are linked on account of the synergistic effects of these pollutants. This raises problems of multi-colinearity and requires that the pollution variables must be carefully selected and specified in the housing price function.

Mishan (1970) states that where an environmental pollutant (e.g., noise) is ubiquitous[(14)], rather than

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(14) In this context, ubiquitous means not that all parts of the country are noisy, but that noise is prevalent in all the areas in which the individual wants or is able to live (due to constraints such as accessibility to work, shops, etc.).

localised, then this limits the householders' ability to move to avoid the pollutant. Hence, he argues that, in such cases, the studies of house price differentials will fail to pick up fully the damage suffered as a result of the noise in a particular location and will also not pick up the effects of a general increase in noise levels. Pearce (1976b, 1978) gives further support to this argument and concludes [Pearce (1976b, p.46)]:-

> "Hence it is not altogether clear that all pollutants are sufficiently localised for the PVV (property value variations) to be a suitable indicator of damage".

(j) The interpretation of the results of the house price studies

In principle, the house price studies could provide a potentially valuable summary indicator of the damage caused by a pollutant. However, it is not certain which types of pollution damages are included in this summary measure nor the extent to which these damages have been captured in the house price studies. This is important since, in assessing the overall damage caused by a pollutant, it is necessary to ensure that no double counting arises from the inclusion of the results of the house price studies alongside the estimates for other specific damages (e.g., cleaning costs, health impacts, etc.). The lack of knowledge on the extent of individual householders' perception of the various types of pollution damage has forced analysts to adopt some 'a priori' and fairly heroic assumptions in combining the house price studies' results with the estimates for specific pollution damages that have been obtained by other techniques in order to yield an aggregate figure for total pollution damage [e.g., see Freeman (1979b)].

An overview of hedonic pricing models

There is a continuing controversy over the validity and relevance of hedonic price studies. Maclennan (1977) points out that a set of assumptions have been adopted in the studies to fill the empty boxes arising from the current lack of knowledge and data. The critics argue that these assumptions are restrictive and unrealistic. Thus Pearce and Edwards (1979, p.213) conclude that:

> "At the theoretical level, the hedonic price technique suffers so many restrictions of a sufficiently severe nature that the only proper conclusion is that it tells us nothing. ... it can and does come up with some magnitudes but what these magnitudes mean is another matter. The argument here is that they mean nothing."

Mäler (1977) concludes that the theoretical shortcomings of the hedonic price studies, along with the data availability and econometric difficulties, mean that they cannot yield meaningful estimates of the willingness to pay for environmental quality.

However, Freeman (1979c) takes a more pragmatic and less condemnatory point of view. He acknowledges that the hedonic pricing studies' assumptions are oversimplified and may not be perfectly realistic and that the empirical estimation procedures followed are not perfect. Nevertheless, he emphasizes that all empirical research is subject to the problems of data availability and discrepancies between the theoretical ideal and the practical realities. Therefore he suggests that the discussion should centre not on whether the hedonic price model is perfect but rather on whether it provides a useful technique for expanding the limited knowledge on the valuation of environmental impacts. To this latter question, Freeman (1979c) gives a qualified yes, although the critics would probably still give a negative answer. Freeman (1979c) concludes that the hedonic pricing technique does offer promise and that, in performing further house price studies, greater care needs to be taken in order to overcome the previous studies' limitations, which were highlighted in sections (a)-(j) above (e.g., in respect of segmentation of the housing market and the careful specification of the variables in the housing price function). Nevertheless, this would present some significant problems for the collection of the necessary data and the performance of the econometric analysis.

3.3.5 Hybrid property models

A 'hybrid' approach was adopted by the Roskill Commission on London's Third Airport[15]. This approach is 'hybrid' in that it adopts a combination of certain aspects of the property price studies and the survey techniques.

Multiple regression techniques could not be successfully used and, instead, a measure of the impact of noise on house prices was obtained from a survey of estate

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(15) Further detailed information and comments on the Roskill Commission's analysis and findings are given in Mishan (1970), Roskill (1971), Paul (1971), Flowerdew (1972) and Pearce (1978).

agents' opinions on this matter. The hybrid approach also does not follow the hedonic models' assumption of a process of continuous adjustment in the housing market. The householders' consumer surplus had to be estimated on account of the discrete adjustments in the housing market that are likely to follow from a non-marginal environmental change, such as the construction of an airport. This was obtained through a questionnaire survey of householders. In the Roskill study, householders were classified according to the following categories: natural movers; noise induced movers; residents remaining in the area; and those moving into the area. The impacts of the noise levels would be different for each of these categories and therefore they were assessed separately. This makes the analysis more realistic but also more complicated.

The Roskill Commission's study has been subject to a number of criticisms [see Mishan (1970), Paul (1971), Dasgupta and Pearce (1972) and Pearce (1978)]. The study is subject to many of the problems and limitations which were highlighted earlier, such as: the selection of a measure for noise [see Paul (1971), Hart (1973) - cited in Pearce (1978)]; starting point bias; the inability or unwillingness of householders to state a monetary figure for their willingness to pay to move from their house; and the failure to specify clearly the extent of the move [see Mishan (1970)]. Moreover, Mishan (1970) and Paul (1971) criticise the Commission's treatment of the consumer surplus element on account of the assignment of an arbitrary figure to those consumers who said that they would not move at any price - i.e., whose consumer surplus was infinite.

3.3.6 Travel costs models

Another and slightly different example of the market based studies is the travel cost models based on the technique developed initially by Clawson and Knetsch (1966). These models entail deriving a demand curve for recreation and estimating the shift in this demand curve resulting from a change in environmental quality. The area between the demand curves then yields a monetary measure of the value of this change in environmental quality. On the basis of the work of Clawson and Knetsch (1966), the demand curve for recreation has been estimated through the use of a trip generation model which includes the travel costs of the visitors from different zones and various other variables(16).

A potential benefit of this technique arises from its direct generation of a monetary value for an environmental change. In addition, recreation benefits form a large proportion of the total benefits resulting from an improvement in water quality [see Freeman (1979b) and OECD (1983)], Moreover, the impacts on visitors' travel costs can

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(16) For further details on the travel costs models and their application to the valuation of the recreation benefits from environmental improvements, see Clawson and Knetsch (1966), OECD (1976), Pearce (1978) and Freeman (1979a, b).

be an important benefit (or cost) item arising from an improvement (or deterioration) in the quality of the environment at a specific site.

Gibson (1978) notes that the Clawson-Knetsch travel costs model has dominated the work on the economics of recreation over the last fifteen years. The model has been adopted in some studies for valuing the impacts on recreation of changes in water quality [e,g, see Stevens (1966), Bouwes and Schneider (1979) and Strand (1980)].

However, this technique is subject to six main difficulties.

The first difficulty concerns the specification of the trip generation model. Clawson and Knetsch's initial model just included the visitors' travel costs [Clawson and Knetsch (1966)]. However, as Clawson and Knetsch did themselves acknowledge, this was not really sufficient since there are a number of other important variables that affect recreation demand (e.g. the income and socio-economic characteristics of the different groups of visitors and the attributes of alternative sites). The OECD report [OECD (1976)] states that the different types of recreation activity undertaken by the visitors (e.g. fishing, swimming, canoeing, walking, etc.) should be taken into account in the classification of visitors in the model.

The omission of important variables could lead to problems of multi-colinearity arising. Strand (1980) comments that his initial model could have been misspecified since it is necessary to include alternative sites in the analysis and that their omission created an upward bias in his estimates. Recent more elaborate studies have attempted to include some of these determining variables. However, there are many complex factors involved in the demand for recreation at a particular site. It is difficult to build up and apply a model that satisfactorily takes into account the various important factors. Thus, Strand (1980) was uncertain as to the extent to which he had been able to overcome the error arising from the misspecification in his initial model by the inclusion of an additional variable to represent alternative sites. Strand (1980) comments that it is an impossible task to specify the Clawson-Knetsch model perfectly. Gibson (1978) concludes that the large data requirement for the recreation trip generation models is a major factor that could prevent their application.

The second difficulty concerns the measure of travel costs used in the model. In their initial work, Clawson and Knetsch (1966) calculated travel costs solely on the basis of distance travelled multiplied by the transport costs per mile. They acknowledge that their failure to allow for the value of the time spent travelling to and from the site and visiting the site leads to under-estimation of the benefits of the recreation site. However, Clawson and Knetsch (1966), along with Freeman (1979a), note that there is considerable uncertainty and controversy concerning the appropriate value of time which will vary for different individuals and for different situations. Freeman (1979a) suggests that the value of recreation-related time could differ from the available figures for the value of commuter travel time. It is also necessary to take into account the utility or disutility of the journey to and from the recreation site. Furthermore, it will be difficult to measure travel costs for sites in urban areas that do not have a large and readily identifiable catchment area. Consequently, the Clawson-Knetsch models could probably not be used for many such urban sites where important environmental improvements and damages can occur (e.g. the creation of urban parks and the littering of these parks).

Thirdly, the Clawson-Knetsch model assumes that the sole purpose of the trip is to visit just the specific recreation site under review and that the costs of the journey can be taken as a surrogate measure of the costs of the recreation visit and the travellers' willingness to pay for the visit. However, in many instances there may be additional purposes for the trip, such as seeing nearby friends or visiting other recreation sites. Freeman (1979a) notes that this latter case raises problems of finding a meaningful method of allocating the total travel costs between the various sites visited. Clawson and Knetsch's allocation procedure for such areas was intuitive.

Cheshire and Stabler (1976) identified another category of travellers, whom they term 'meanderers', that do not conform to the pure single site recreation visitor assumed in the Clawson-Knetsch model. They suggest that Clawson-Knetsch models may have to be abandoned in favour of consumer survey techniques in order to estimate the willingness to pay of such meanderers. Gibson (1978) comments that the existence of these other categories of visitors, along with the problems concerning the travel cost measure discussed earlier, threatens the basic foundations of the Clawson-Knetsch method and means that considerable research is needed if recreation benefits can be successfully valued by Clawson-Knetsch models.

Clawson and Knetsch's work was directed at valuing the benefits related to the quantity of recreation facilities provided. The fourth difficulty arises from the application of Clawson-Knetsch models to the valuation of the benefits arising from changes in the quality of the site (e.g. a lake). This concerns the problems involved in estimating the effect of a change in effluent levels upon water quality, (see section 3.3.1) selecting an appropriate measure of water quality and then determining the impact of changes in water quality upon the demand for recreation. The last two problems are compounded by the heterogeneous nature of recreation which encompasses many diverse activities (e.g. fishing, swimming, boating, hiking, etc.) that are affected by different aspects of water quality [see Turner (1977)]. Freeman (1979a) criticises the water quality measures that are commonly adopted in studies of recreation benefits. He notes that it is difficult to determine objective water quality measures that consumers perceive as being important for recreation. He goes on to say that this lack of knowledge concerning consumers' perception of water quality creates uncertainty over the extent to which the impacts of environmental changes upon the users of a water body have been included in the estimates generated by a recreation benefits study. In relation to the last problem, some empirical recreation benefit studies have used postulated values for this fundamental variable in the evaluation process [e.g. Stevens (1966), Bouwes and Schneider (1979)][17]. Turner (1977) reports that limited progress has so far been made in resolving these problems surrounding the water quality variable and that this substantially limits the effectiveness of studies valuing the benefits of water quality improvements.

Fifthly, difficulties can be encountered in deriving an aggregate national estimate of environmental damages or benefits on the basis of the values given by a Clawson-Knetsch type analysis of a specific site, on account of the particular characteristics of this individual site.

A final difficulty with the travel costs models is their omission of the benefits of a water quality improvement for non-users of the specific recreation site under review. This includes the 'option value' benefits. This omission might require that a Clawson-Knetsch type study was supplemented by consumer surveys of the general population.

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(17) For a critique of these studies' treatment of this important aspect, see Turner (1977).

To sum up. The travel costs models could potentially generate monetary estimates for the value of the recreational benefits foregone as a result of environmental pollution at a particular (rural) site. However, it is evident that this technique is subject to a number of practical difficulties which could limit the validity of the estimates generated. In this respect, it is worth noting that Clawson and Knetsch (1966), in their original work, advocated that the travel costs model should be a preliminary technique which just provided 'ball park' estimates. Finally, the practical difficulties with the travel costs models could mean that it would not be possible to apply them in certain situations, especially urban locations.

Instead of the Clawson-Knetsch type travel costs models, Freeman (1979a) prefers the participation models that have been used in some studies of the recreational benefits from environmental improvements [e,g, see Davidson et al 1966), National Planning Association (1975), Battelle (1975)][18]. This approach involves data requirements, assumptions and estimation techniques that are less stringent than those of the Clawson-Knetsch models. Nevertheless, significant difficulties still arise concerning the specification of the demand function for recreation and the water quality variable. Moreover, this approach requires the use of an imputed value for a recreation visit in order to convert into monetary terms the physical estimates generated

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(18) For a review of these participation models, see Freeman (1979a) and OECD (1983).

by the participation models[19]. This raises problems concerning the uncertainty and controversy over the appropriate value.

3.3.7 Use of experts' assessments

One method, that has been adopted in some studies of the environmental impacts, is to seek the assessments of the experts in the relevant field[20]. It was noted earlier, that consumers frequently could not perceive fully the impacts, especially the long run impacts, of a certain pollutant. Further, that it is difficult and expensive to design a questionnaire survey which gives the consumers the necessary information so that they are able to comprehend and answer correctly the questions, but without the provision of this information biassing their replies. In contrast, the experts and official authorities will be much better informed about the environmental impacts being studied. Therefore, a more cost-effective method of determining the significance of

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(19) In this respect, the participation models are similar to the physical measurement techniques, (e.g. mortality/morbidity studies), which were considered in section 3.3.1, and encounter the same sort of problems concerning the derivation of physical estimates and their conversion into monetary units.

(20) Freeman (1979b) reports on the results of two such dose-response estimation studies that were based upon the opinions of experts [Aherne (1973), Gillette (1977)]. Freeman (1979a) also reports that experts' assessments of the water quality at a number of lakes were used in David's (1968) house prices study. The Roskill Commission on London's third airport used the assessments of estate agents to determine the impacts of noise on house prices. Further examples of the use of experts' consensus approach for the evaluation of the damages of environmental pollutants are the studies by Theys (1977) and Lowe and Lewis (1981).

an environmental issue is, as a first step at least, to ascertain the assessments of the experts in the field and the official authoritative bodies on the subject. Thus Rowen (1975) states that these can be two principal sources of information on environmental impacts.

3.4 The development of a 'best practicable' approach towards the valuation of environmental impacts

The last three sections have demonstrated some important conceptual and practical problems involved in assessing complex environmental issues. In particular, the previous section highlighted that the performance of a full economic evaluation of certain environmental impacts may not be feasible on account of data constraints. Nevertheless, a decision must be made concerning these environmental impacts. Therefore it is essential to find a method of providing the decision-makers with the relevant information to enable an appropriate assessment to be made of such impacts. This section then builds on the analysis in the previous three sections and develops a 'best practicable' approach that could be applied to the assessment of complex environmental impacts, such as those generated by carbonated beverage container systems, for which significant data constraints are apparent.

3.4.1 The general principles behind the 'best practicable' approach

This 'best practicable' approach is based upon a constrained decision-making process model which is concerned with the greatest possible achievement of an objective subject to certain constraints. Such a 'maximisation subject to constraints' approach to policy evaluation has been advocated by Crocker (1975), Dorfman (1976) and Roberts (1976). This approach is similar to the decision-making model incorporating bounded rationality that was developed by Simon [see Simon (1955)][21].

This thesis follows the National Academy of Sciences (1975) and Rowen (1975) in considering that the objective of an evaluation of an environmental issue is to act as an aid and to provide a (supplementary) input of information to the (political bodies) who ultimately make the decision on the issue[22]. This data collection and presentation role of the analyst has been emphasised by Mishan (1975) and Freeman (1979a).

The constraints are the practical problems involved in the provision of this information. This concerns the quality of the available data and the difficulties and costs of obtaining additional information. The provision of information does entail certain costs which increase as more detailed information is required. Thus, even the more elaborate valuation techniques are subject to many important practical difficulties, some of which can only be overcome at considerable cost. Williams (1972) and Roberts (1976)

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(21) For a review of Simon's work on this subject, see Jackson (1982).

(22) If, as should occur in a democracy, the political decision-making body comprises the diverse interested parties and pressure groups, each with different aims and ideas about the study, then this can pose severe problems for the analyst as he attempts to determine just what necessary information this body wants.

emphasise the necessity of recognising at the outset, rather than ignoring, these practical constraints that are inherent in the real world.

In adopting this 'best practicable' approach, it is important that the most efficient methods of providing the various levels of appropriate information are being considered. This is analogous to ensuring that the most efficient pollution control techniques are being adopted so that points lying on the curve for the firms' marginal costs of pollution control are being examined.

The selection of a specific methodology involves ascertaining the extent to which more detailed and comprehensive information should be provided. This requires a balancing of the benefits of the additional information provided and the costs of its acquisition. Thus the optimum methodology will be that which equates the marginal benefits of information with the marginal costs of requiring information.

3.4.2 The application of this concept of the 'best practicable' approach.

A sequential procedure should be followed for the application of the 'best practicable' approach, which involves two main stages:-

Stage I - Identification of the physical size of the environmental impacts.

Stage II - Determination of the significance and monetary valuation of these physical impacts.

Such a sequential approach for the evaluation of environmental benefits was proposed by Rowen (1975) and Roberts (1976). This approach was also adopted by Freeman (1979b) in his report on the benefits of pollution control for the U.S. Council on Environmental Quality.

The National Academy of Sciences (1975) stress that a policy evaluation framework should be sufficiently flexible so that it can be appropriately applied to the particular circumstances of each study. These particular characteristics can be split into two main categories: First, the availability of the necessary data and the ease or difficulty of acquiring additional information. These factors determine the costs of providing information. Second, the financial resources allocated to the study and the importance attached to the acquisition of this information which determines the benefits of providing information. The extent to which it is desirable and feasible to follow through the sequential stages and the actual details and comprehensiveness of the information provided will vary depending upon these particular circumstances. Therefore only the general aspects concerning the application of this approach are presented here. In the following chapter, this approach is applied to the evaluation of the environmental impacts of beverage containers and methodologies are outlined for the evaluation of the various types of impacts involved[23].

3.4.2(i) Stage I - The identification of the physical size of the environmental impacts

The first stage of an evaluation should be the collation of information on the physical quantities involved (e.g., the quantities of pollutants generated) and the physical impacts of the pollutants (e.g., the nature and numbers of cases of damages occurring). If precise quantitative information is not available on these matters, then it will be necessary to report the estimates and opinions of the experts and the authoritative bodies on the approximate order of magnitude of the physical quantities involved.

Information on the physical impacts forms a fundamental building block for the performance of economic evaluations of environmental impacts. The accuracy and

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(23) The terminology used throughout this thesis is defined as follows: this chapter develops a 'best practicable' approach for the evaluation of environmental impacts which is based upon consideration of the costs and benefits of providing additional information. Chapter 4 and the following empirical Chapters 5-9 then outline two particular types of methodologies or techniques for the evaluation of the environmental impacts of carbonated beverage containers: A 'best practicable' methodology which are the evaluation techniques that had to be adopted in this thesis on account of the data constraints encountered during the performance of the research; and a 'best available' methodology which identifies the techniques that should be adopted if a more elaborate (economic) evaluation of the impacts should be required and if more adequate resources and information were available for this.

validity of economic evaluations will be limited by any shortcomings of the physical information on which they are based.

In some cases, it may be sufficient and more meaningful to supply the decision-makers with just physical information on the impacts so that they can then make their own valuations of these impacts. This procedure was proposed in the OECD report for the conference on noise abatement policies [OECD (1980)] and was adopted in the OECD report on the Costs and Benefits of Sulphur Oxide Control [OECD (1981, p.96)], which stated that:

> "It was felt inappropriate to transform mortality benefits in monetary terms, because the method of valuation is not universally agreed upon. In any case, the mortality impact carries a significant message on its own without the addition of an economic evaluation which would only increase the level of uncertainty in the results."

However, in many other areas, it will be desirable for the analyst to supplement the physical impact results by providing additional information concerning the significance of these impacts so that the decision-makers can determine their valuations of these impacts. Therefore the second stage should be considered in these cases.

3.4.2(ii) Stage II - The determination of the significance of the environmental impacts.

In the acquisition of this additional information, it is proposed that a two-step process should be followed. The first step comprises a review of the opinions of experts and authoritative bodies to ascertain the informed 'official' view of the significance of the problem[24].

If this (preliminary) review indicates that the issue was considered to be of sufficient importance and that the benefits of additional detailed and monetary information on this issue exceed the costs of acquiring it, then the next step would be undertaken - the performance of a more detailed economic evaluation. Section 3.3 surveyed some of the main alternative economic evaluation techniques (consumers' surveys, market based studies, etc.). This indicated that, when it is possible to undertake thorough consumer surveys which overcome the possible pitfalls associated with this method, then this probably represents the most viable technique for valuing environmental impacts. However, the choice of the appropriate technique to be adopted will depend upon the specific circumstances of a particular case (e.g., the nature of the environmental impacts being studied, the type of information required and the resources available for acquiring it)[25]. Chapter 4 identifies the appropriate techniques for the evaluation of the various types of environmental impacts generated by the beverage container systems.

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(24) In practice, this review may well be undertaken at the same time or before a full physical impact study. But the important point to note here is that this review should be undertaken before the decision is made concerning the next stage - the acquisition of more detailed information through the performance of the more elaborate studies.

(25) If more than one technique is selected, then it is important that the results are carefully presented and interpreted to ensure that any possible double counting is avoided [see section 3.3.4(j)].

If it is considered necessary to obtain a more detailed and monetary evaluation, then the sequential approach presented here will yield further benefits since the physical impact studies and the review of the authorities' opinions will indicate those important impact areas to which the (probably limited) resources and efforts should first be directed.

In those areas for which it is not feasible to perform detailed economic evaluations, alternative methods have to be sought for providing the decision-maker with the appropriate information. This important issue is discussed at length in the following section. From this discussion it appears that for these unquantifiable impacts it is best to provide the decision makers with data and information on the physical size of these impacts. This should be supplemented by information on the nature of these physical impacts, along with the opinions of authoritative experts and other available information concerning the significance of these impacts so that the decision-makers can themselves make their own valuations of these impacts.

3.4.2(iii) Important issues concerning the 'best practicable' methodology.

It has been advocated by some [e.g., see Hahn and Bate (1978)] that systems analysis should be used to derive quantitatively physical estimates for the environmental impacts and that systems analysis could thereby provide a suitable method of reviewing areas of social policy.

However, the objective of assessing environmental impacts is to ascertain the importance that society places on these impacts. Kneese and Bower (1968) and Lee (1982) point out that such physical measures, on their own, are not very meaningful for the decision-makers since they do not give an indication of the significance of the various impacts. Hahn and Bate (1978) suggest that this problem should be overcome by presenting the detailed and disaggregated physical data generated by the systems analysis models and then leaving it to the political decision-makers to determine their own assessment of the significance of these impacts. However, Lee (1982) notes that this could present the decision-makers with a mass of information which may well be difficult to understand adequately and is likely to confuse rather than assist the decision-makers who desire a manageable and comprehensible statement of a problem.

Therefore, the National Academy of Sciences (1975) and Freeman (1979a) suggest that, in preparing and presenting the evaluation, the analyst should organise and filter the 'raw' data so as to reduce this mass of information that the decision-makers have to assimilate.

Mishan (1975) and Freeman (1979a) advocate that the analyst's organising and filtering function should be based upon the allocative criteria of welfare economics. Thus Mishan (1975, p.383) states that:

> "We might surmise that, in the absence of any other incentive, the need for politicians to assimilate an otherwise unmanageable mass of price-quantity data in order to reach decisions on economic policy would compel economists to formulate allocative propositions."

Freeman (1979a, p.10) also argues that the benefits of an environmental policy should be measured and presented in a commensurate unit - money - which would enable aggregation and comparison of diverse environmental impacts. Moreover, this would enable direct comparisons and trade offs between an environmental policy's benefits and its costs, which are usually presented in monetary terms. Thus the economic evaluation tool, Cost-Benefit Analysis (as strictly defined) attempts to value all impacts in terms of money and to arrive at a single quantitative and monetary figure as the conclusion. However, this has led to criticism by many, including economists [e.g., see Rowen (1975)], as well as non-economists [e.g., see Self (1970), Hahn and Bate (1978)], about the assumptions and monetary weights adopted in such analyses, especially for certain intangible factors which may then not be correctly taken into account in the final decision and may be ignored altogether. Haveman and Weisbrod (1975) stress that these qualitative impacts must still be appropriately taken into consideration in the decision. Freeman (1979a) also reports that many people are distrustful of attempts to value in money terms such things as human life, ecological and aesthetic impacts. Peskin and Seskin (1975) report that there is concern that the assigned values can be arbitary and misleading. Thus, Rowen (1975, p.367) states that:

> "trying to collapse output measures into a dollar measure of benefits usually obscures more than it reveals."

This tendency towards monetary quantification can, to a certain extent, be due to the analyst's simplification of the data and the temptation on his part to achieve firm quantitative results. This is also admitted by economists, such as Mishan (1975, p.160) who advocates that:-

> "In our growth-fevered atmosphere there is always a strong temptation for the economist, as for other specialists, to come up with firm quantitative results. In order to be able to do so, however, he finds that he must ignore the less easily measured spillovers. The economist should resist this temptation."

Nevertheless, there are three important factors that must be borne in mind in respect of these criticisms.

First, there is pressure from the political decision-makers themselves for the analyst to present such simplified (monetary) quantitative measures of the costs and benefits of an environmental policy. Moreover, there is a tendency for the political decision-makers to overlook the qualitative elements and to concentrate on the quantitative items while disregarding the (sometimes severe) limitations and assumptions behind these figures. Consequently, the findings of a study can be misinterpreted and, in particular, misplaced and spurious concreteness can be attached to some of the results. This is ably brought out by Lecomber (1978, p.6) when he states that:-

> "These are perhaps criticisms not so much of the quantification and valuation per se but of the way in which figures are used and presented........ It should be remembered that the reader will tend to be biassed towards the quantifiable and that this bias will need to be countered by giving extra stress to the qualitative elements."

Second, the National Academy of Sciences (1975), Roberts (1976) and Freeman (1979a) emphasise that some decision must be made on the valuation of the tangible and intangible environmental impacts. Even ignoring the environmental issue involves an implicit valuation that the environmental impacts are not sufficiently significant to warrant action.

The National Academy of Sciences (1975) and Roberts (1976) state that these valuations should be made by the political decision-making body. Accordingly, Haveman and Weisbrod (1975) conclude that the important question is not whether the intangible impacts <u>can</u> or <u>should</u> be measured but rather <u>how</u> they should be measured and the results presented so that they are of most assistance to the decision-makers.

The National Academy of Sciences (1975) and Haveman and Weisbrod (1975) point out that implicit valuations are much less subject to scrutiny and debate than where they are explicitly identified and measured in a thorough economic evaluation. Thus the National Academy of Sciences (1975, p.167) states that:

> "Choices about trade-offs unavoidably involve placing relative values on non-commensurable effects such as dollars versus life. These values can be hidden if the information is not displayed in the appropriate framework, or they can be brought out in the open. The use of the proper framework for presenting information on non-commensurate effects can make the value implications of alternative choices clearer and allow the decision-maker to confront the valuation problem openly and explicitly."

Similarly, Fisher and Lecomber (1978, p.5), in their analysis of pollution taxes, state that:

> "Under the current regulation system - and in any consideration of the pollution question - the government has to decide what level of control costs should be justifiably incurred in order to reduce pollution levels. Hence, the government is implicitly putting a value and price on the intangible benefits to be gained from reductions in pollution levels. What the system of taxes does is to make this value explicit and hence make it more susceptible to public scrutiny."

However, Baram (1980) has argued that valuations in some cost-benefit analyses have been made behind the scenes by an unaccountable analyst. This is also noted by Mishan (1975), who states that the filtering and data organising function does give the analyst some potentially arbitrary powers. In addition, Nash et al (1975) note that cost-benefit analyses have often been used to justify a public decision that had already been made. Accordingly, Nash et al (1975) and Lee (1982) stress that an evaluation of an environmental issue should be part of and should contribute towards an effective public participation in a decision on an environmental issue. Hence, this involves a broad interpretation of the term 'public decision-makers' and highlights the importance of the evaluation giving an explicit and comprehensible presentation of the information required.

The third important factor concerning the criticsms of Cost-Benefit Analysis is that the alternatives to Cost-Benefit Analysis are themselves also subject to considerable limitations. In particular, neither the political approach and intuition nor the pure physical impact studies may be adequate for the consideration of complex matters, such as an environmental issue. It was the resulting need to supplement the political approach by providing the decision-makers with some more substantive information on the issue that was one of the prime reasons for the development of economic evaluation techniques, such as CBA. Williams (1972, p.223) stresses this importance of the limitations of the alternatives to CBA when he points out that:-

> "It is salutory to be reminded of the limitations of the current state of our knowledge, both in principle and in practice. The other great danger is that the perfect becomes the enemy of the good, that the acknowledged limitations of the new product are made the excuse for not abandoning old practices which have even more defects, on the curious notion that we should only change over if a perfect product is offered in place of the imperfect one we are already using. CBA is not the way to perfect truth but the world is not a perfect place and I regard it as the height of folly to react to the greater (though still incomplete) rigour which CBA requires of us by shrieking '1984' and putting our heads hopefully back into the sands (or clouds) in the hope that things will look better again in fifteen years time."

and when he states (p.201) that:-

> "Unfortunately, the valid criticisms are applicable to the only alternative techniques of analysis, and all too often the argument appears to degenerate from attempts to replace poor analysis by better, to assertions that since analysis is difficult, costly and troublesome, we should abandon it! It is not a conclusion I can share."

The fourth factor concerning these criticisms is that they relate to cost-benefit analysis as strictly defined and applied. Thus Rowen (1975, p.367) argues that:

> "Cost-Benefit Analysis in its conventional form has very limited utility. There are two principal reasons. First, there is the difficulty - in some cases the impossibility - of attaching money values to such outputs as scientific results, large areas

> of national security, or basic education. In these areas, valuation problems are so severe that cost-benefit analyses are rarely done. Even in more tractable areas, like housing, transportation, and pollution control, each of which involves important intangibles, it may not be worth the allocation of an analyst's time to produce (often with great ingenuity) a conventional cost-benefit analysis."

Rowen (1975), along with the National Academy of Sciences (1975), argues that cost-benefit analysis should not be used to dictate choices nor to replace the political decision-makers by generating a monetary conclusion concerning a project or policy. Instead, they advocate the use of a cost-benefit analysis framework to identify the relevant factors that need to be studied and the relevant items on which information should be presented(26). They suggest that a broad definition of cost-benefit analysis should be adopted for the evaluation of environmental impacts. Under this broad approach, economic valuation techniques should be used where they are feasible and useful but a (possibly arbitrary) monetary value should not be assigned to the unquantifiable impacts. Instead, the existence of such unquantifiable impacts should be highlighted so that they can be appropriately taken into account in the final decision. Consequently, some impacts would then be measured in monetary units, while certain other unquantifiable impacts would be specified in some other terms. This raises an important 'Apples and Oranges'

(26) Chapter four develops such a cost benefit analysis framework for the evaluation of beverage container policy measures. This details the impact items that need to be considered and demonstrates how to avoid possible double counting.

valuation problem of how the diverse impacts can be presented so that meaningful aggregations, comparisons and trade offs can be made. Four alternative methods of tackling this important problem are now considered.

At one extreme, there is the conversion of all the impacts into the commensurable unit - money. Such strictly defined cost-benefit analysis were shown earlier to be unsatisfactory on account of the difficulties over the (possibly arbritrary and hidden) values assigned to certain intangibles and the decision maker's and the public's distrust of the simple quantitative values generated as conclusions under this approach.

At the other extreme is the presentation of all the diverse impacts in just physical terms. This approach was also shown earlier to be unsatisfactory since it would present the decision-makers with a complex mass of information which, on their own, would not provide any guidance concerning the relative significance of the diverse environmental impacts.

A third alternative and intermediate approach is based on the broad interpretation of 'Cost-Benefit Analysis' and seeks to combine the beneficial aspects of these two extremes. Thus, under this approach, economic techniques would be used to value as many as possible of the impacts in the commensurable unit of money. While those impacts for which it was not feasible to perform an economic valuation, but which may nevertheless still be significant, the analyst would give estimates of their physical size or, where quantiative physical data are not available, report the approximate order of magnitude of the physical impacts involved. In addition, relevant information would be provided to aid the decision-makers determine the significance of these impacts. This could include information on: the nature of the impacts; the opinions of authoritative experts on the significance of these impacts; contingency valuations identifying the values for these impacts which would mean that they outweigh the monetised impacts; and, where possible, perhaps delineating maximum and/or minimum values (e.g. under best and worst cases).

Such 'ball park' estimates could be used to indicate the relative significance of certain impacts. For instance, they could supplement the contingency valuations by indicating whether an unquantifiable impact is likely to attain the critical contingency values. Such contingency calculations could be valuable where there is just one intangible impact (or a single set of similar intangible impacts) which could then be compared with the net value of the monetised cost and benefit items. However, it may not be possible to adopt such procedures where there are a myriad of intangible impacts occurring on both the costs and the benefits side. In such cases, it will be difficult to draw up a direct trade off between the net monetary value of the quantifiable costs and benefits and the other diverse unquantifiable costs and benefits. Lee (1982) suggests that the analysis could usefully be simplified by filtering out impacts for certain items which were below a threshold level of significance. Therefore the additional information could be used to indicate whether certain impacts were below this threshold level and hence could reasonably be ignored.

The information should be presented in a systematic and explicit way which clarifies relevant options, focuses the decision-makers' attention onto the important valuations and trade offs that have to be made, highlights their implications and identifies the important economic, social and political factors underlying these valuations and trade offs(27).

The following aspects should also be clearly pointed out in the study: the scope of the analysis, in particular any areas that have not been included; the methodology adopted; important assumptions behind the data presented (particularly concerning any 'ball park' estimates); the limitations of the available data and important gaps in the current knowledge about the subject under review; and any resulting uncertainty about the accuracy of the data presented. In such cases of uncertainty, a range of likely values should be reported or a sensitivity analysis performed where this is possible and useful, or the valuation should be undertaken for a number of scenarios incorporating different values for important variables.

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(27) For detailed information on how estimates of the benefits of environmental policies should be presented, see Freeman (1979a, pp.8-10).

A fourth alternative method of aggregating the diverse incommensurable impacts is the use of multi-criteria analysis, such as concordance analysis. This technique involves first drawing up a physical impact matrix denoting the proposed projects' or policy options' impacts upon certain environmental criteria. Each criteria would be measured in their own appropriate units. The decision-makers' weights would then be derived for the various impact criteria. Pairwise comparisons would be performed. Concordance and discordance sets and matrices and concordance and discordance dominance indices would then be computed[28].

The appeal of this technique is that it enables the diverse impacts to be placed side by side and a series of computations performed which generate as conclusions a set of specific figures that indicate the relative merits of the different options and thereby aid the decision-makers' choice between these options. However, this technique is subject to a number of practical difficulties.

The technique requires good physical data on the likely impacts under the different options. These data will not be available in many actual cases, the environmental impacts of beverage containers being one such example. In an attempt to overcome this difficulty, Nijkamp (1977) proposes that qualitative multi-criteria analysis or ordinal concordance analysis should be used instead. However, these

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(28) A detailed description of this technique is given in Nijkamp (1977).

variants of the basic multi-criteria analysis would no longer generate identifiable specific figures as conclusions. Furthermore, the values or indicators attached to the qualitative impacts could be criticised as being subjective and arbitrary.

Moreover, it is doubtful whether the decision-makers would be able to understand the output matrix generated by a concordance analysis, which would appear even more mystical and confusing than the monetary figures given by cost-benefit analysis. Furthermore, they are unlikely to be able or willing to comprehend the complex procedures adopted under this technique and the (subjective) value judgements and assumptions adopted in the computations. Consequently, the decision makers and the public may be even more distrustful about a technocratic solution generated by concordance analysis, than they are about the monetary results given by cost-benefit analysis.

Finally, the weights assigned to the various criteria are fundamentally important in determining the outcome of a concordance analysis. However, these weights could be subject to considerable uncertainty and controversy. In relation to this difficulty, Nijkamp (1977) suggests that either sensitivity analysis or contingency analysis or a stochastic analysis could be performed to reveal the effects of using different weights. However, such procedures would not overcome the main problem concerning this aspect, which is how to determine initially valid weights that accurately reflect the decision-makers' preferences. Nijkamp (1977) considers that interviews should be used for this. However, in order that the interviews could yield meaningful results, the physical impacts would have to be presented in units that the various decision makers can comprehend. Furthermore, it would be necessary to provide the decision-makers with considerable additional information on these impacts so that the decision-makers can properly understand their nature and significance and hence give an appropriate weight or value to them.

It is apparent that this information would be similar to that which has just been detailed under the previous alternative. Therefore, rather than replace the 'simple' monetary conclusions generated by a strictly defined cost-benefit analysis by some equally mystical figures generated by the sophisticated computations involved in a concordance analysis or by the complex mass of information generated by a physical impact study, it would appear that the most practicable procedure is offered by the third alternative. This incorporates the use of economic evaluations, where these are feasible, supplemented by a qualitative treatment of the unquantifiable impacts. This qualitative treatment would comprise provision of the additional information highlighted earlier to enable the decision-makers to determine their own valuations of these impacts.

3.5 Conclusion

The objective in valuing environmental impacts is identified, in section 3.1 of this chapter, as being to gain a better understanding of the nature, magnitudes and significance of the environmental impacts and hence enable the decision-makers to ascertain the importance that society places on the environmental impacts under review. Section 3.2 demonstrates that the political and economic approaches to achieving this objective both have limitations and section 3.3 illustrates the many practical problems of obtaining detailed information on the valuation of environmental damage costs.

Section 3.4 addresses the particularly important problem of aggregating, comparing and determining the significance of the results presented for an analysis of an environmental issue covering diverse impacts. Three quantitative methods of tackling this problem are examined: physical impact studies; economic evaluation techniques, such as Cost-Benefit Analysis (CBA); and recently developed sophisticated weighting procedures, such as concordance analysis.

Physical impact studies can yield much valuable, fundamental information. However, this technique can lead to the presentation of a complex mass of data which can confuse rather than aid the decision-makers who desire that the raw data should be filtered and presented in a meaningful form. In particular, the physical data, on their own, do not provide any guidance on the significance of diverse impacts that are presented in different units of measurement. This presents a difficult 'apples vs oranges' comparison and valuation problem.

As strictly defined, Cost-Benefit Analysis attempts to value all the impacts in a common unit-money. An important benefit of such economic valuation techniques is that this use of a commensurate unit facilitates the aggregation and comparison of diverse environmental and economic impacts. However, there are considerable difficulties surrounding the determination of monetary valuations for certain intangible impacts which nevertheless may still be important and should be appropriately taken into account in the final decision. Thus the public and the decision-makers are critical of the monetary weights assigned to such impacts in CBA and they distrust the simple monetary conclusions generated by a strictly defined cost-benefit analysis.

Significant practical problems are likely to be encountered in the performance of sophisticated weighting procedures, such as concordance analysis. Moreover, it is doubtful whether the decision-makers would be willing or able to comprehend these complex techniques and the (subjective) value judgements and assumptions involved in the computations. Consequently, the public and the decision-makers are likely to be even more distrustful of the quantitative conclusions generated by concordance analysis.

Thus these quantitative alternatives are subject to considerable shortcomings and, on their own, they are not appropriate for the evaluation of environmental impacts, such as those generated by carbonated beverage containers, for which significant data constraints are apparent.

Instead, this thesis has developed a 'best practicable' approach for the assessment of an environmental issue. This attempts to achieve, to the greatest extent possible, the purpose of an environmental study, which is identified as being to act as an aid and a (supplementary) input of information to the decision-makers, while taking into account the data constraints and the costs of acquiring additional information. This 'best practicable' approach comprises a sequential procedure which involves the following stages:-

Stage I - Identification of the physical size of the environmental impacts

Stage II - Assessment of the significance of the physical impacts, which entails two steps:-

(i) First, a review of the experts' and authoritative bodies' assessments of the significance of these impacts

(ii) Then, if it is considered feasible and worthwhile, a detailed economic evaluation of these impacts.

This 'best practicable' approach involves a broad interpretation of Cost-Benefit Analysis. Under this approach, the sequential procedure should be followed and economic evaluations undertaken for as many as possible of the impacts. Nevertheless, in many cases, there will remain some impacts for which an economic evaluation cannot be performed. Section 3.4 demonstrates that relevant qualitative information should be provided on the magnitude, nature and significance of these unquantifiable impacts, so that decision-makers can themselves determine the appropriate valuations of these impacts.

The extent to which these sequential stages should be performed depends upon the particular circumstances of each case (e.g., the current availability of data, the ease or difficulty of acquiring additional information, the importance that is attached to the acquisition of this information, and the financial resources allocated for the study). In the following chapters, this 'best practicable' approach is applied to the valuation of the environmental impacts of beverage containers.

P A R T   I I I

APPLICATION OF THE THEORETICAL FRAMEWORK TO THE BEVERAGE CONTAINER ISSUE

CHAPTER 4

A CONCEPTUAL FRAMEWORK FOR A SOCIAL APPRAISAL OF THE BEVERAGE CONTAINER ISSUE

Introduction

Section 2.1 of Chapter 2 demonstrated the importance of setting out a sound conceptual framework for analysing an environmental issue. This need for a framework is particularly apparent for a topical and controversial environmental issue such as the disposal or re-use of beverage containers, on which there is a considerable amount of literature from the industry and environmental groups and from international and national governments and organisations(1). On the basis of the theoretical foundations presented in the previous Chapters 2 and 3, this chapter develops a framework for a social appraisal of the beverage container issue. This framework will enable the literature from the environmentalists and the industry to be seen in perspective and would enable the relevant information in this literature to be appropriately included in an empirical assessment of this issue.

- Section 4.1 examines the current position in the beverage container market. This provides a brief description of the alternative returnable and non-returnable beverage container systems investigated in this thesis.

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(1) This literature is reviewed in OECD (1978) and in an earlier paper [Fisher (1978)].

- Section 4.2 briefly considers the conditions for the attainment of the social optimum in the beverage container market.
- Section 4.3 then sets out a framework for a social appraisal of returnable and non-returnable beverage containers. The main causes of any divergence between the current position in the beverage container market and the socially efficient optimum are identified, and some criteria are presented for the evaluation of the alternative policy options.
- Section 4.4 outlines the scope and objectives of this particular thesis.
- The final section 4.5 outlines the general methodology that is adopted for the empirical assessment of the external costs of beverage containers in the following Part IV.

4.1 The current position in the beverage container market

4.1.1 Definitions

4.1.1(i) Internal and external costs and benefits of beverage containers.

Chapter 2 demonstrated that the distinction between internal and external costs and benefits is of fundamental importance in a social appraisal of an issue. Therefore, it is useful first to refine somewhat the general definition of these terms, given earlier, by applying them specifically to beverage containers.

- Internal Costs and Benefits are the costs and benefits which the consumer fully perceives and which the beverage producers (manufacturers, distributors and retailers) take into account in making their choice between the alternative containers.
- External Costs and Benefits arise where the production and distribution of beverages in the

alternative containers and the disposal of the containers create impacts which affect the welfare of other members of society, and where there are no traded markets or property rights concerning these impacts. Therefore, the individual producers and consumers do not take these impacts upon others into account in their production and consumption decisions concerning packaged beverages. In the absence of any government intervention, there is no incentive or compulsion for them to do so under the current market system. Consequently these impacts are imposed on society as a whole and remain uncompensated (if they are costs) or unappropriated (if they are benefits).

4.1.2 Description of the alternative returnable and non-returnable systems currently used for the distribution of beverages

Figure 4.1 presents a flow diagram which highlights the process stages involved in the distribution to the consumer of beverages in non-returnable bottles and cans and in returnable bottles.

It can be seen from figure 4.1 that an essential difference between the returnable and non-returnable systems is the re-use loop operated for the returnable system. In the 'off' premise[2] sector of the beverage market, the consumer drinks the beverage away from his place of purchase and then has to return the bottle to the shop. In some cases, this may be inconvenient. Hence, the convenience

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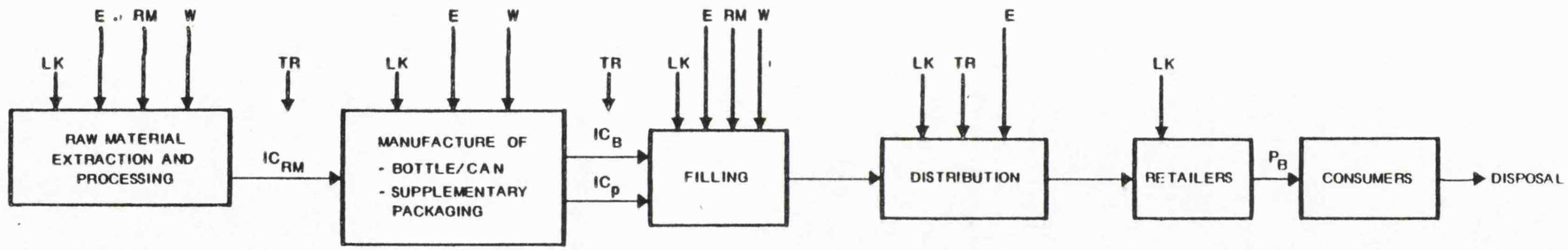
(2) The 'off' premise sector comprises sales of beverages, principally from off licences and other retail outlets, for consumption away from the place of purchase. The 'on' premise sector comprises sales in pubs and door-to-door deliveries.

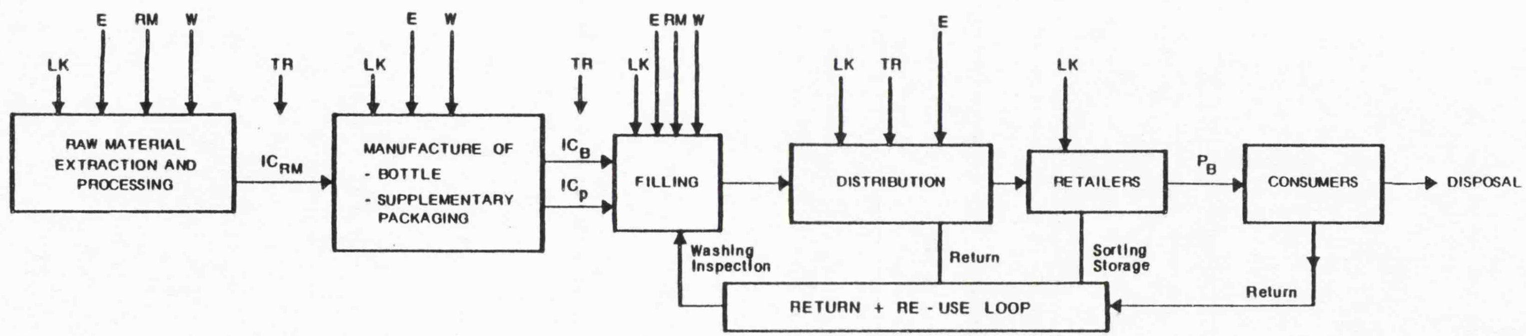
Figure 4.1

PROCESS STAGES IN THE RETURNABLE AND NON-RETURNABLE CONTAINER SYSTEMS FOR CARBONATED BEVERAGES

A. Non-Returnable Systems



B. Returnable Systems



Where Internal Input Categories

LK = Labour, capital, land (e.g. Space) and other factor inputs.
E = Energy.
RM = Raw materials.
W = Water.
TR = Transportation to next process stage.
IC_{RM} = (Internal) Cost or price of processed raw materials.
IC_B = (Internal) Cost or price of container.
IC_p = (Internal) Cost or price of supplementary packaging.
P_B = Price of packaged beverage to the consumer.

characteristics of the one-way disposable non-returnables will be one of the (internal) attributes of the alternative containers that affect the consumers' preferences for each container type.

The total internal costs for each container system comprise the internal costs that are incurred at each of the process stages shown in figure 4.1.

In the U.K., all the returnable bottles for carbonated beverages are made of glass. Similarly, the non-returnable bottles used for carbonated beverages are mostly glass bottles[3]. Two main types of metal cans are currently used for carbonated beverages. The most common is a bimetallic can, which has a tinplate base and body and an aluminium top with an aluminium ring pull for easy opening. In addition, an all aluminium can is also marketed.

A returnable bottle is heavier than an alternative non-returnable bottle since it is designed to be re-used. The glass bottles are heavier than the metal beverage containers and the aluminium can is the lightest of these containers for carbonated beverages. Soft drinks bottles and cans are heavier than their counterparts for beer on account of the greater internal pressure of soft drinks carbonation.

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(3) A non-returnable 2-litre plastic (PET) bottle for carbonated beverages has been developed recently and has just entered the U.K. market. However, this bottle currently has only a very small share of the market and, by 1982, is predicted to account for 1.35 per cent of the total 'off' premise sales of beer, cider and carbonated soft drinks in the U.K. Therefore, this plastic bottle has not been included within the scope of this thesis which concentrates upon the major glass and metal containers currently used for carbonated beverages.

Glass bottles require more protective packaging than the metal cans. Thus, returnable glass bottles are usually distributed to the retail outlets in plastic crates (which are also returnable) and non-returnable glass bottles are packed in paperboard cartons with a covering of shrink wrap plastic; while, for their distribution, the metal cans are usually shrunk wrapped in plastic with just some cardboard along the edges.

4.1.3 Comparison of the internal costs of the alternative returnable and non-returnable container systems

The filling, distribution and retailing costs are generally higher under the returnable system on account of the lower filling speeds, greater space and handling requirements for the heavier returnable bottles and crates and the return processes involved in their re-use. The distribution, retailing and supplementary packaging costs are generally higher for the non-returnable glass bottles than for the non-returnable metal cans due to the bottles' greater weight and the more supplementary paper packaging required for glass bottles(4)(5).

The heavier returnable bottle is more expensive (in purely financial terms) than the non-returnable glass

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(4) On account of the re-use of the returnable crates in the returnable system, the costs of supplementary packaging (per unit of beverage delivered) for returnable bottles may well be lower than the supplementary packaging costs for the non-returnable systems.

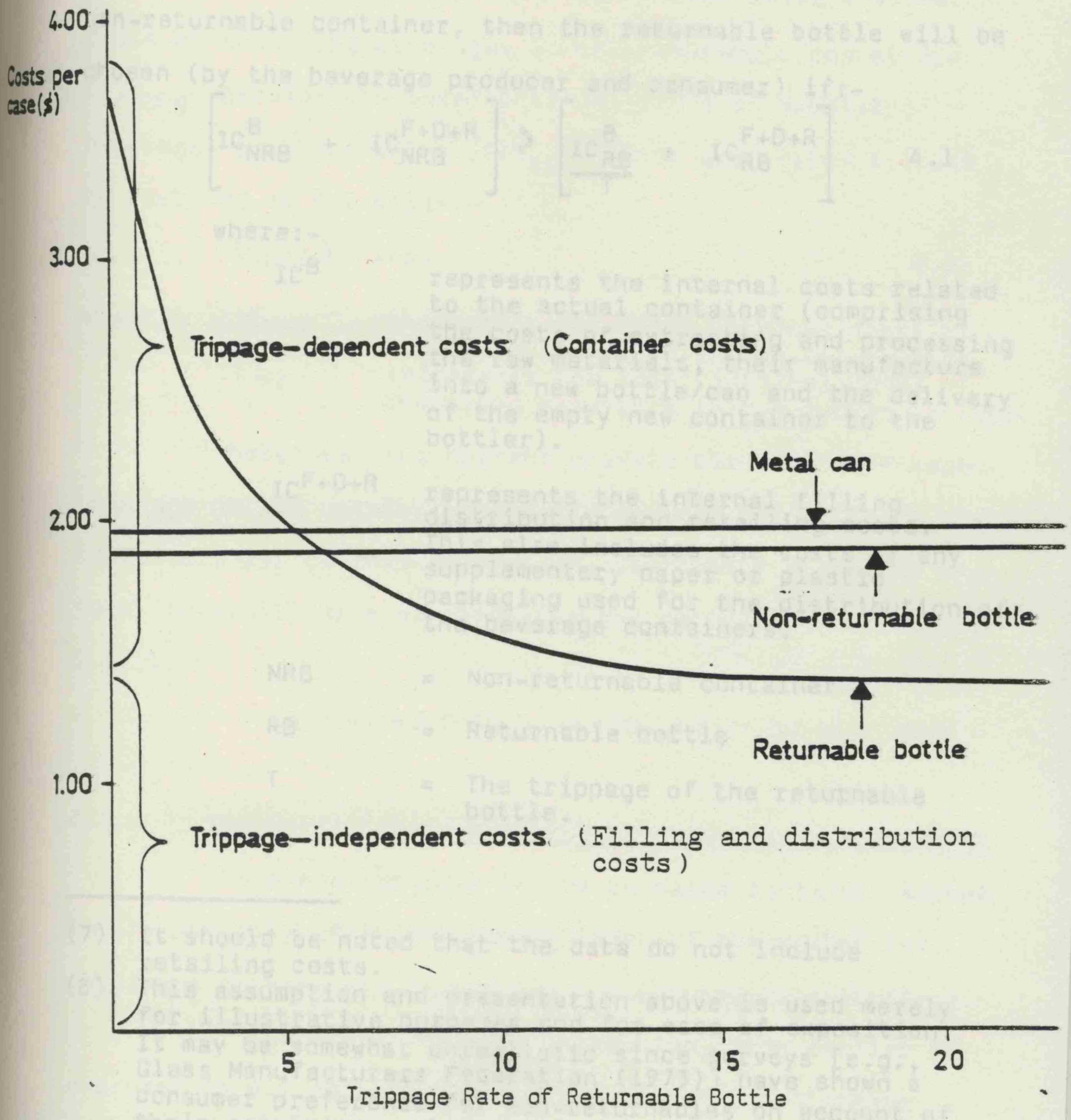
(5) A more detailed description of the characteristics and internal advantages and disadvantages of the returnable and non-returnable glass bottle and can systems is given in an earlier paper [Fisher (1978)] and in publications by the industries concerned [e.g., see INCPEN (1975), Schweppes)].

bottle, although the returnable bottle is much the same price and, if anything, slightly cheaper than the non-returnable cans[6]. However, in order to determine the beverage container system with the lowest internal costs, what must be compared is not just the internal costs at a single process stage (such as the production of an individual alternative container), but the costs for the total system costs of all the process stages involved in the delivery of a certain quantity of beverage to the consumer. These process stages include the filling, distribution and retailing of the beverage containers, along with the production of the empty containers (see Figure 4.1). The cost of an individual returnable bottle will be amortised by the number of times that this bottle is used for filling and delivering beverages - or its trippage. Thus an essential factor in the internal cost comparison of the alternative container systems is the trippage achieved by the returnable bottles since this determines whether the lower container costs, resulting from their amortisation by the returnable's trippage, offset the extra filling, distribution and retailing costs of the returnable system. The effect of variations in the trippage rate is shown diagrammatically in figure 4.2 which presents some US data on container filling and distribution costs of

(6) It was estimated (in June 1979) that a half pint (10 oz.) returnable bottle cost about 4p., while a half-pint non-returnable glass bottle cost between 2.5-3p. and a 10 oz. bimetallic can cost about 4.9p.

Figure 4.2

Comparison of the internal costs of supplying packaged beer in non-returnable containers and returnable bottles with different trippages - U.S. (Oregon) Data for 1972 in US $ (1972 prices).



Source : Stern et al (1975)

Notes : (1) Trippage dependent costs are the costs that vary with the trippage rate i.e. the costs of the individual bottle which will be amortised by the number of trips achieved by that bottle. Trippage independent costs are those costs which are incurred regardless of whether a new or a returned bottle is used (e.g. filling and distribution costs).

(2) It would appear that a case contains 24 x 12 oz. bottles or cans.

the returnable and non-returnable container systems in Oregon[7].

If one makes the assumption[8] that the consumer is indifferent whether the beverage is in a returnable or a non-returnable container, then the returnable bottle will be chosen (by the beverage producer and consumer) if:-

$$\left[IC^{B}_{NRB} + IC^{F+D+R}_{NRB} \right] > \left[\frac{IC^{B}_{RB}}{T} + IC^{F+D+R}_{RB} \right] \quad 4.1$$

where:-

IC^{B} represents the internal costs related to the actual container (comprising the costs of extracting and processing the raw materials, their manufacture into a new bottle/can and the delivery of the empty new container to the bottler).

IC^{F+D+R} represents the internal filling distribution and retailing costs. This also includes the costs of any supplementary paper or plastic packaging used for the distribution of the beverage containers.

NRB = Non-returnable container

RB = Returnable bottle

T = The trippage of the returnable bottle.

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(7) It should be noted that the data do not include retailing costs.

(8) This assumption and presentation above is used merely for illustrative purposes and for ease of exposition. It may be somewhat unrealistic since surveys [e.g., Glass Manufacturers Federation (1973)] have shown a consumer preference for non-returnables on account of their convenience characteristics. However, the principle shown in expressions 4.1 and 4.2 still holds since the returnable container will now be chosen if:-

$$TIC_{NRB} - \text{Consumer premium}_{NRB} > TIC_{RB}$$

In other words, the consumer would not choose the non-returnable unless his valuation of this convenience premium exceeded any extra internal costs of the non-returnables.

All the cost items (IC) are the costs at the appropriate process stages for the supply of a certain quantity of packaged beverage (e.g., 100 pints of beer).

Expression 4.1 can be summarised as saying that the returnable container will be chosen if the total internal costs of supplying beverages in non-returnable containers (TIC_{NRB}) exceeds the total internal costs of supplying beverages in returnables (TIC_{RB}). Thus expression 4.1 can be restated as 4.2 below:-

$$TIC_{NRB} > TIC_{RB} \qquad 4.2$$

where:- TIC_{NRB} represents the total internal costs of supplying beverages in non-returnables.
TIC_{RB} represents the total internal costs of supplying beverages in returnable bottles.

Therefore, the current private mix of the packaged beverage market between returnable and non-returnable containers is, on this assumption, that which minimises the total internal costs of producing and delivering beverages, i.e.:-

$$\text{minimises } (TIC_{NRB} + TIC_{RB}) \qquad 4.3$$

4.2 The social optimum in the beverage container market

The social optimum in the beverage container market is the socially efficient sub-division of the market for beverages between returnable and non-returnable containers.

If one makes the same assumption, made earlier in expressions 4.1 and 4.2 above, of consumer indifference between beverages in returnable and non-returnable containers, then this socially optimal mix of the packaged beverage market between returnables and non-returnables is that which minimises the total social (i.e., internal plus external) costs of producing and delivering packaged beverages.

i.e.:

$$\text{minimises } (TIC_{NRB} + TEC_{NRB} + TIC_{RB} + TEC_{RB}) \qquad 4.4$$

where:- TIC_{NRB}, TIC_{RB} are as defined for expression 4.2 above

TEC_{NRB}, TEC_{RB} represent the total external costs of non-returnables and returnables, respectively.

4.3 A social appraisal of returnable and non-returnable beverage containers

Chapter 2 demonstrated that a social appraisal of an environmental issue requires first an assessment of whether there is any divergence between the current position and the social optimum. This will determine whether the government should consider intervening in this area. If there is any significant divergence, then the second stage of the appraisal should be performed - an evaluation of all the policy options. The first part of this section analyses the causes of any divergence between the current position in the beverage container market and the socially efficient optimum position. The second part then draws up some criteria for evaluating the alternative policy measures concerning the beverage container question.

4.3.1 The causes of any divergence between the current position and the social optimum for the beverage container market

Chapter 2 demonstrated that any divergence between the current market position and the social optimum will be caused by the existence of any imperfections in the current market mechanism. There are three areas of market imperfections that appear to be particularly relevant to the beverage container issue. These are:-

- (I) Imperfections which result in a lack of consumer sovereignty
- (II) The existence of potentially relevant externalities
- (III) The consumption of finite resources, such as energy, which are considered to be incorrectly priced.

4.3.1(i) Lack of consumer sovereignty

This concerns whether the consumers' current decisions in the market place represent their true preferences. It has been argued that the consumers' purchase of a non-returnable may not necessarily reveal a consumer preference for beverages in non-returnable rather than returnable containers if these consumers do not have full information and freedom of choice concerning the alternative containers to purchase their beverages in and, if the container is returnable, in being able to return the bottle. The existence and extent of any lack of consumer sovereignty in the market for beverages in the various containers depends upon the following four factors:-

- (i) The availability at the various retail outlets of beverages in the alternative types of containers.
- (ii) The comparative advertising levels for beverages in returnables and non-returnables.
- (iii) The information that the consumer receives when he purchases a beverage in a returnable or non-returnable container. This will be

affected by the bottlers' and retailers' customary practices for identifying whether a bottle is returnable or non-returnable and whether or not the retailers separate the price of the beverage as distinct from the refundable deposit on the bottle.

(iv) Whether there are any significant impediments for consumers wanting to return bottles to the retail outlets.

4.3.1(ii) <u>The existence of externalities</u>

The importance of externalities to a social appraisal of beverage containers is effectively highlighted by the minimum cost expressions for the current position and the social optimum in the beverage container market,given earlier in expressions 4.3 and 4.4, which are restated below:

(I) Minimum cost expression for the current private mix of the packaged beverage market between returnables and non-returnables:

minimise $(TIC_{NRB} + TIC_{RB})$ 4.5

(II) Minimum cost expression for the social optimum:

minimise $(TIC_{NRB} + TEC_{NRB} + TIC_{RB} + TEC_{RB})$ 4.6

A comparison of expressions 4.5 and 4.6 shows that the existence of any external costs of beverage containers (the terms TEC_{NRB}, TEC_{RB} in expression 4.6) will result in a divergence between the current position and social optimum for beverage containers. The terms TEC_{NRB} and TEC_{RB} relate to the beverage container systems' generation of external impacts which are unpriced under the current market mechanism. This includes the following five areas:-

(i) The disposal of beverage containers in domestic solid waste (SW).

(ii) The disposal of beverage container as litter[9] (L).

(iii) Air and water pollution emissions and solid waste generated at the process stages for the returnable and non-returnable container systems shown in figures 4.1 and 4.3 (EP).

(iv) Public health and hygiene impacts arising from the presence of any contaminants in the packaged beverage and from the storage of the beverage containers at the retail outlets (H).

(v) The environmental impacts resulting from the transportation between the various process stages. In particular, the urban traffic congestion caused by the distribution of the beverage containers to the retail outlets (U).

4.3.1(iii) <u>The consumption of incorrectly priced finite resources</u>

Chapter 2 outlined a number of imperfections relating to the market for finite resources which could result in the current market price and depletion rate of finite resources, such as energy (and perhaps other raw materials), differing from the socially optimal levels. Therefore, this third category of market imperfection should include the energy (and perhaps other raw materials) that are consumed at the various process stages of the alternative container systems identified in figure 4.1.

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(9) Litter is defined as material that is not immediately placed in the recognised system of waste disposal and collection [e.g., the householders' dustbins noted in (i) above]. This material then imposes external costs in the form of the expenditure that local authorities and parks departments have to incur to control litter and, if the litter is not picked up, then in the form of the aesthetic eyesore and public nuisance resulting from the litter that is left on the ground in public areas.

However, it must be noted that the beverage industry does at present pay for energy and raw materials and that these energy and raw materials costs are included in the total internal costs of supplying beverages in the alternative containers. Therefore, in a social appraisal of beverage containers, the consumption of energy and raw materials should be weighted by the difference between the market price currently paid by the beverage industry for energy and raw materials (P_E) and the long-run social opportunity cost of the current consumption of these finite resources (λ_E). The direction and importance of this difference ($\lambda_E - P_E$) will depend upon the net effect of the various market imperfections identified in chapter 2.

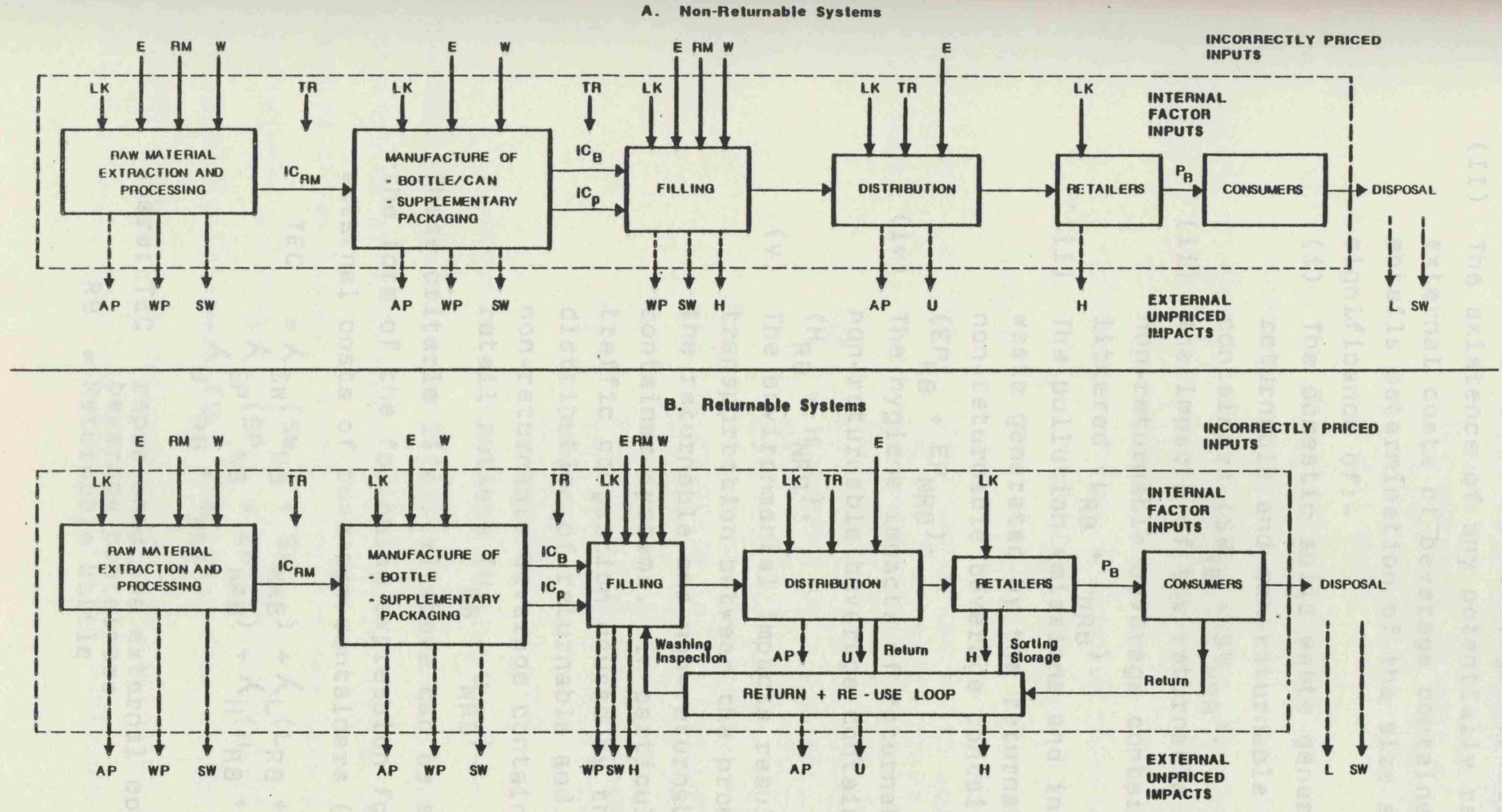
These last two categories of market imperfection are highlighted schematically in figure 4.3, which distinguishes between the internal and the incorrectly priced inputs and the external impacts of the beverage container systems. The internal factors appear in figure 4.3 within the box made up by the dashed lines (----). The resources which might be considered to be incorrectly priced appear above the upper dashed line. The external impacts of the beverage container systems are shown below the lower dashed line.

4.3.1(iv) <u>Criteria for the consideration of intervention in the beverage container market</u>

Therefore, the question of whether the government should <u>consider</u> intervening in the beverage container market, depends upon the following criteria:-

Figure 4.3

PROCESS STAGES IN THE RETURNABLE AND NON-RETURNABLE CONTAINER SYSTEMS FOR CARBONATED BEVERAGES



Where Internal Input Categories

LK = Labour, capital, land (e.g. Space) and other factor inputs.
E = Energy.
RM = Raw materials.
W = Water.
TR = Transportation to next process stage.
IC_{RM} = (Internal) Cost or price of processed raw materials.
IC_B = (Internal) Cost or price of container.
IC_p = (Internal) Cost or price of supplementary packaging.
P_B = Price of packaged beverage to the consumer.

External Output Categories

AP = Air pollution emissions.
WP = Water pollution emissions.
SW = Solid wastes.
L = Litter.
U = Urban traffic congestion.
H = Hygiene impacts of any contaminants in the packaged beverage and from the storage of the beverage containers at the retail outlets.

(I) If there is any evidence of the four factors, noted earlier, resulting in any lack of consumer sovereignty in the beverage market.

(II) The existence of any potentially relevant external costs of beverage containers. This entails determination of the size and significance of:-

(i) The domestic solid waste generated by returnable and non-returnable beverage containers ($SW_{RB} + SW_{NRB}$).

(ii) The impacts of the returnable and non-returnable beverage containers that are littered ($L_{RB} + L_{NRB}$).

(iii) The pollution emissions and industrial solid waste generated by the returnable and non-returnable beverage container systems ($EP_{RB} + EP_{NRB}$).

(iv) The hygiene impacts of returnable and non-returnable beverage containers ($H_{RB} + H_{NRB}$).

(v) The environmental impacts resulting from the transportation between the process stages of the returnable and non-returnable beverage container systems. In particular, the urban traffic congestion caused by the distribution of returnable and non-returnable beverage containers to the retail outlets ($U_{RB} + U_{NRB}$).

These criteria II(i)-(v) above can be summarised in the form of the following expression for the total external costs of beverage containers (TEC):-

$$\begin{aligned} TEC &= \lambda_{SW}(SW_{RB} + SW_{NRB}) + \lambda_{L}(L_{RB} + L_{NRB}) \\ &+ \lambda_{EP}(EP_{RB} + EP_{NRB}) + \lambda_{H}(H_{RB} + H_{NRB}) \\ &+ \lambda_{U}(U_{RB} + U_{NRB}) \end{aligned} \quad 4.7$$

where: TEC represents the external costs of beverage containers

RB = Returnable bottle

NRB = Non-returnable container
SW = Domestic solid waste
L = Litter
EP = Air and water pollution emissions and industrial solid waste generated
H = Hygiene and public health impacts
U = Environmental impacts of the beverage container systems' transport
λ = Social valuation of these externalities (i)-(v) above

(III) The level of the returnable and non-returnable beverage container systems' requirements of finite resources for which the long-run social opportunity cost (λ_E) differs from their current market price (P_E). This can be presented in the following expression 4.8:-

$$C_E = (\lambda_E - P_E)\ (E_{RB} + E_{NRB}) \qquad 4.8$$

where:

C_E represents the extra social valuation (above the market price paid) for the beverage container systems' consumption of finite resources
E_{RB} represents the consumption of finite resources (e.g., energy and raw materials) in the returnable container system for beverages
E_{NRB} represents the consumption of finite resources in the non-returnable container system for beverages
P_E represents the market price currently paid for the finite resource
λ_E represents the social opportunity cost of the current consumption of the finite resource

In order to determine the direction in which the government should be considering intervention (i.e., favour returnables or non-returnables), it is further necessary to examine three issues. First, whether the lack of consumer sovereignty adversely affects consumers who want to purchase beverages in returnable or non-returnable containers. Second, whether the returnable system generates more or less external costs than the non-returnable container systems.

This entails a ranking of the alternative container systems in terms of each of the external cost categories II(i)-(v) identified above. Third, whether the returnable system requires more or less energy and raw materials than the non-returnable systems. For three of the categories of external costs (solid waste, litter, water and air pollution) and for the consumption of energy and raw materials, it is worthwhile to identify separately the returnable system's external costs and energy and raw material requirements that arise from the production and disposal of the returnable bottle and hence which are affected by the re-use of this bottle. This separation is presented in expressions 4.9-4.12 below, which show that the ranking for these aspects depends upon whether:-

$$\frac{SW_{RB}}{T} \gtrless SW_{NRB} \qquad 4.9$$

$$\frac{L_{RB}}{T} \gtrless L_{NRB} \qquad 4.10$$

$$\frac{EP^{B}_{RB}}{T} + EP^{F+D+R}_{RB} \gtrless EP_{NRB} \qquad 4.11$$

$$\frac{E^{B}_{RB}}{T} + E^{F+D+R}_{RB} \gtrless E_{NRB} \qquad 4.12$$

where the items in expressions 4.9-4.12 are as defined earlier in expressions 4.1 and 4.7.

Expressions 4.9-4.12 highlight the importance of the trippage achieved by the returnable bottle .

4.3.2 Policy evaluation

4.3.2(i) Alternative policy measures

The legislation, directives and policies concerning carbonated beverage containers that have been promulgated in various countries are outlined in Appendix I. This survey of international legislations reveals that there are a number of alternative policy measures relating to the beverage container issue. The three main categories of the principal policy options are listed below:-

(I) <u>No action by the government</u>

(II) <u>A 'Voluntary' agreement between the government and the beverage industry</u> (can and bottle manufacturers, bottlers and retailers) that the beverage industry will itself undertake measures to attain certain specified objectives such as:-

(a) The level of beverage containers disposed in domestic waste should not increase or should decrease by a certain amount.

(b) The recycling of glass and metal cans should increase to reach a certain target.

(c) The performance of an effective litter control programme.

(d) Limits on the amount of beverages sold in non-returnables.

(e) Improvements in the design and weight of beverage containers.

(f) Improvements in the returnable system by:-
- promotion of standardisation
- increasing trippage
- provision of (more) information for the consumers on: which bottles are returnable with refundable deposits; where the consumers can buy beverages in returnable bottles; and where they can return the empty bottles
- measures to make it easier for consumers to return bottles.

(III) <u>Government intervention in the market for packaged beverages</u>. Such measures include:-

(a) Bans on the use of certain types of non-returnable containers for carbonated beverages.

(b) The mandatory imposition of refundable minimum deposits on beverage containers.

(c) A variant of (b) above, is the legislation in Michigan (USA) which requires that a mandatory deposit of 10¢ be put on all carbonated beverage containers but that a lower minimum deposit of 5¢ should be placed on 'certified' standard returnable beverage containers which can be re-used by more than one bottler.

(d) Standardisation of bottle size and shape.

(e) Mandatory availability provisions requiring that retailers give equal shelf space and choice for the consumer between returnables and non-returnables.

(f) Mandatory acceptance provisions specifying that the retailer must accept and refund the deposit on any returned empty container of the same type, brand and size as those sold by him.

(g) The mandatory identification on the bottle or its label that it is returnable for a specified deposit refund.

(h) The levying of a high tax on non-returnables.

(i) A low 'litter' tax on major items of litter to finance an anti-litter campaign. Such a tax was introduced in the State of Washington (USA). Beverage containers were included within the scope of this tax.

(j) A product charge on packaging items, including beverage containers, to cover their 'external' waste collection and disposal costs.

(k) The 'bottle bill' legislation originally passed in Oregon, and subsequently in other American States, which bans metal beverage cans with detachable ring pulls [measure (a) above] and combines the levying of mandatory deposits on certified and non-certified beverage containers [measure (c)], with mandatory retailer acceptance provisions [measure (f)], and a mandatory identification of the refund value of the bottle [measure (g)].

(l) Other combinations of the measures (a)-(k) above have also been adopted in various countries, provinces or states.

In relation to the U.K., the current position is that a recent report by the Waste Management Advisory Council [WMAC (1980)] recommended that the government should not intervene in the packaged beverage market to implement measures against non-returnables. Instead, WMAC principally recommends that various type II voluntary measures should be undertaken by the beverage industry. Thus WMAC (1980, p.7) recommends that:

- The recycling of beverage containers should be increased, where this viable [measure II(b) above].
- The beverage industry should endeavour to improve the existing returnable system by undertaking a continuous campaign to raise trippage and by agreeing on a greater degree of standardisation [measure II(f)].

- The bottlers should collaborate with the retailers to ensure that the consumer is informed that the price of a carbonated beverage in a returnable includes a (refundable) deposit [measure II(f)].
- All returnable bottles should bear a clear indication of returnability [measure III(g)]

In contrast, Friends of the Earth in their minority report [Cawdell (1980, p.20)] recommend that the following intervention measures should be undertaken by the government:

- Mandatory deposits should be imposed on all returnable and non-returnable containers for carbonated beverages, with a lower deposit being permitted for certified standard bottles that can be re-used by more than one filler and whose national retail sales are greater than 5 million units [measure III(c) above].
- Retailers should be required to accept back all containers of the type, size and brand sold by them and to accept back any standard container stocked (up to some limit per customer per day) [measure III(f)].

4.3.2.(ii) Criteria for policy evaluation

In the light of the many alternative policy options and these contrasting recommendations that have been made for the U.K., it is essential to establish some definite criteria for the evaluation and selection of the 'best' policy measure(s) for the U.K. This thesis concentrates here on highlighting the major points and principles concerning the criteria for the selection of the optimum policy. This is designed to identify the various impact items that need to be considered in the selection of the 'best' policy measure, and to demonstrate how to present information on the level and significance of these impact items so as to ensure that double counting or omissions do not occur. More detailed information on these criteria is given in OECD (1978, section 5A).

The objective of this policy evaluation process should be to determine that policy measure which yields the greatest level of social welfare. Chapter 2 showed that, in order to achieve this objective, it is necessary to take into account the environmental impacts and the economic impacts of the various policy options.

(A) Environmental impacts

(1) The external costs of beverage containers

The environmental impacts of a policy include any changes in the level of the following external costs of beverage containers:-

(i) Generation of domestic solid waste
(ii) Litter
(iii) Air and water polution emissions and industrial solid wastes
(iv) Hygiene and public health impacts
(v) Environmental impacts of transportation. In particular, urban traffic congestion

(2) The conservation of resources

The environmental impacts of a policy measure also include its impact on the beverage container systems' consumption of finite resources (e.g. energy and raw materials), the current prices and consumption levels of which are considered to be incorrect.

(B) Economic impacts

The economic impacts of a beverage container policy comprise the impacts of the policy on the beverage industry, beverage consumers and the government sector. The policy measure may affect the operations, employment and investment levels of the various sectors involved in the process stages of the beverage container systems (i.e., bottle and can manufacturers, brewers and bottlers, distributors and retailers). Such impacts would result in changes in the total internal costs of supplying the consumer with beverages in the alternative returnable and non-returnable containers. To the extent that this results in changes in the price of beverages for the consumer, the policy's impact on the price of beverages in the alternative containers can therefore be an effective and useful summary measure of the economic impact of the policy. Consequently, changes in the price of packaged beverages have been used as a summary indicator in recent studies on the economic impact of beverage container policies [e.g., see Maryland Department of Economic and Community Development (1976)].

However, there are a number of factors which could result in this measure failing to capture (fully) certain impacts of the policies. Therefore, it is also necessary to take these factors into account.

<u>Consumer convenience and choice</u>

In addition to changes in the price of packaged beverages, the consumer will be affected by the convenience with which he/she is able to purchase beverages in the various containers and then dispose of or return the container. As far as disposal is concerned, it is frequently more convenient for consumers to purchase non-returnables rather than to purchase returnables and then return the bottle. Therefore, it is necessary to take into account the policy's impacts on the <u>convenience</u> benefits consumers obtain from purchasing beverages in non-returnables. Like-wise, it is also necessary to take account of the policy's impact on the <u>inconvenience</u> for the consumer of returning bottles to the retail outlets. Consumers' welfare will also be affected by the policy's impacts on other aspects affecting consumer sovereignty, such as the provision of information and consumers' freedom of choice. This latter aspect will be influenced by the policy's effect upon the availability at the retail outlet of beverages in the desired container sizes and types.

<u>Price controls</u>

The existence of any government price controls may mean that the beverage industry is not able to pass any increases in internal costs on to the consumer in the form of increased prices. This means that it will also be necessary to assess the policy's impacts on the profit levels of the beverage industry. Alternatively it may be simpler to assess the economic impacts of the policy in terms of its effect on the <u>total internal costs of packaged beverages</u> (TIC), which are shown in expression 4.13 below:-

$$TIC = TIC_{NRB} + \frac{IC_{RB}^{B}}{T} + IC_{RB}^{F+R+D} \qquad 4.13$$

If the policy resulted in a lowering in the total internal costs, and hence possibly prices, of supplying the consumer with packaged beverages, then this would constitute an economic benefit of the policy and, vice versa, an increase in the total internal costs would constitute an economic cost of the policy.

Employment of labour

The labour costs incurred by the beverage industry are included as one of the cost items in the total internal costs function given above in expression 4.13. However, in a social appraisal, the employment of labour should be weighted, not by the wage rates actually paid as applied in the internal costs function above, but by its shadow wage (W_λ)[10]. This shadow wage rate is the opportunity cost to society of employing the labour in that job instead of its best alternative job. The high levels of unemployment currently experienced in many parts of the country by many categories of labour (especially unskilled labour) mean that there may be few alternative jobs available so that the shadow wage rate is low. On account of social considerations and imperfections in the labour market, however, this shadow wage rate could be less than the wage rate actually paid for these categories of labour[11]. Therefore, social benefits would accrue from an increase in the employment opportunities for these categories of labour. Recent government measures to increase employment opportunities, such as the activities of the Manpower Services Commission, the Job Creation

(10) A more elaborate discussion of this matter is given in Mishan (1975).

(11) There may also be some instances where, on account of the effect of incomes policies and rigidities in the labour market, the shadow wage for a specific category (e.g., skilled labour) may exceed its actual wage rate.

Programme and the Training Opportunities Placement Scheme, give some support to this view. It is therefore necessary to ascertain the policy's impacts on the employment levels for the various categories of labour in the beverage industry. These changes in employment levels should then be weighted in the social appraisal by the difference between the shadow wage and the wage rate actually paid by the industry for the various categories of labour so that the appraisal can give an indication of the social costs and benefits of the employment impacts of a policy measure.

Capital obsolescence and investment

The policy may result in the obsolescence of certain capital equipment (e.g., filling lines). This would not show up in the cost and price changes if the beverage producers adopt the economic principle that 'byegones are byegones'. Thus, although a producer would attempt to raise prices and hence increase his revenue so as to earn an adequate return on any additional new investment, he would not do so for obsolescent equipment which should be written off as an irretrievable capital loss. Therefore, in the social appraisal, any capital equipment rendered obsolete as a result of the policy measure should be included as an additional item and should be valued at the (social) productivity of this equipment in the absence of the policy less any revenue the beverage producer obtained from the sale of this equipment. OECD (1978) also reports that it has been suggested that the impacts upon the beverage industry's investment levels and, hence, capital resources may be of such importance that they merit special assessment. However, it is important to note that a firm's investments are already included in the firm's calculations of its total internal costs (e.g., by depreciation, interest charges, etc.). Therefore, to avoid double counting, the investment impacts should only be included as a supplementary item in the economic impact statement where this importance or social valuation of these investments exceeds the allowance that has already been made in the calculation of the beverage industry's total internal costs. Moreover, in the social evaluation of policies, the impacts of a policy upon a firm's investment should only be weighted by this excess of the social valuation of the investment requirements over the allowance for the costs of this investment which has already been made by the beverage industry.

Other factors

Other factors that need to be taken into account include the impacts of the policy upon the competitive structure of the beverage industry, the distribution of income, the balance of payments, the international trade implications of the policy and the impacts on the government sector. This latter factor includes the administrative feasibility and costs of implementing the policy and the impacts upon government revenues and expenditures. Further information on these other factors is given in the OECD report [OECD (1978)].

The criteria for the evaluation of the various policy options can thus be summarised as including the impacts of the policy upon:-

(i) The external costs of beverage containers, which are shown in expression 4.14 below:-

$$TEC = \lambda_{SW}\left(\frac{SW_{RB}}{T} + SW_{NRB}\right) + \lambda_L\left(\frac{L_{RB}}{T} + L_{NRB}\right) \quad 4.14$$

$$+ \lambda_{EP}\left(\frac{EP^{B}_{RB}}{T} + EP^{F+D+R}_{RB} + EP_{NRB}\right)$$

$$+ \lambda_H(H_{RB} + H_{NRB}) + \lambda_U(U_{RB} + U_{NRB})$$

(ii) The conservation of resources which is represented by expression 4.15, below:-

$$C_E = (\lambda_E - P_E)\left(\frac{E^{B}_{RB}}{T} + E^{F+D+R}_{RB} + E_{NRB}\right) \quad 4.15$$

(iii) The total internal costs of supplying the consumer with packaged beverages, which are represented by:-

$$TIC = TIC_{NRB} + \frac{IC^{B}_{RB}}{T} + IC^{F+D+R}_{RB} \quad 4.16$$

(iv) Employment levels in the beverage and related industries which should be represented by:-

$$\sum_{i=1}^{n} \left[empl^{i}(W^{i}_{A} - W^{i}_{\lambda})\right] \quad 4.17$$

where:

i = i^{th} category of labour

n = No. of categories of labour

$empl_i$ = the policy's impacts on the employment levels for the i^{th} category of labour in the beverage industry.

W^{i}_{λ} = the shadow wage for the i^{th} category of labour.

W^{i}_{A} = wage rate paid by the beverage industry for the i^{th} category of labour.

(v) Capital obsolescence and investment requirements of the beverage and related industries whicn should be represented by:-

$$IV(\lambda_{IV} - IC_{IV}) + OC(\lambda_{OC} - NRV_{OC}) \qquad 4.18$$

where:

IV = the investment undertaken by the beverage industry as a result of the policy measure

λ_{IV} = the social opportunity cost of the firm's capital resources used to finance this investment

IC_{IV} = the firm's internal costs associated with this investment

OC = capital equipment rendered obsolete as a result of the policy measure

λ_{OC} = the social productivity of this capital equipment in the absence of the policy measure

NRV_{OC} = revenue received by the beverage industry from the sale of this equipment

(vi) Consumer convenience, consumer inconvenience, consumer choice and other aspects relating to consumer sovereignty.

(vii) Other factors which include impacts upon the industry's competitive structure, the distribution of income, balance of payments and the government sector.

Some important considerations concerning these criteria

Two particular factors will play an important part in determining the economic and environmental impacts of a policy measure. These are the market shares held by the alternative beverage containers and the trippage that is achieved by the returnable bottle(12). This is particularly evident in expressions 4.14, 4.15 and 4.16 above which highlight that these two factors are important determinants of the total external and internal costs and the resource requirements of the alternative beverage container systems. Significantly, they are also two factors which a beverage container policy can alter. Therefore, in the formulation of a beverage container policy, it is essential that the policy should be designed so as to raise trippage.

Finally, for the evaluation of the alternative policy measures, it is necessary to have a baseline against which to compare the impacts of each of the policy options. This baseline should be the policy 'off' or 'No Action' case and will be represented by the values for such important factors as the market shares and trippage that would have occurred in the absence of any policy measure.

4.4 The scope of this thesis

4.4.1 The external costs of carbonated beverage containers

This thesis analyses the external costs of carbonated beverage containers. This analysis covers the following five areas:

(i) The disposal of beverage containers in domestic solid waste.

(ii) The littering of beverage containers.

(iii) The pollution emissions from the alternative beverage container systems. The thesis concentrates upon the emission of air and water pollutants.

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(12) The other important variables determining the size and nature of the economic and environmental benefits of beverage container policies are analysed in depth in the OECD report [OECD (1978)].

(iv) Public health and hygiene impacts arising from the presence of any contaminants in the packaged beverages and from the storage of the beverage containers at the retail outlets.

(v) The environmental impacts resulting from the transportation between the various process stages in the beverage container systems. In particular, the thesis concentrates on the urban traffic congestion caused by the distribution of the beverage containers to the retail outlets.

Reasons for studying these particular areas

An earlier review of the available information in the (U.K. and overseas) literature [Fisher(1978)] highlighted the distinct lack of U.K. data and information on the external costs of beverage containers. It was noted earlier in Chapter 3 (page 79) 'that it is ideally necessary to undertake a specific........ study for each particular situation or, if this is not feasible, to exercise considerable caution in applying the results of other studies to a different situation'. Therefore, there was a need to compile some U.K. data on this subject especially since bodies such as the Waste Management Advisory Council have consistently stressed that any decision on the beverage container situation in the U.K. should, as far as possible, be based upon U.K., rather than overseas, data and information. Thus the Waste Management Advisory Council (1980, p.1) state in their report that:-

> "It soon became apparent, from our examination of the literature, that because of differences in geography, social habits, distribution systems and other factors, it would be difficult to draw conclusions valid for the United Kingdom from the experience in other countries, notably the USA. We

considered that we needed first to collect basic data about the different beverage container systems in this country and then seek to assess the economic and environmental impacts of these systems and the effects of possible changes. Only then would we be able to reach informed conclusions on what action, if any, was desirable and what form it should take."

This study examines three issues concerning these external cost areas .

(I) The significance of the external costs of carbonated beverage containers. This will aid the determination of whether the government should consider intervention in the carbonated beverage container market.

(II) The external cost ranking of the alternative containers for carbonated beverages. This will aid the determination of the direction in which the government should be considering intervention (i.e., favour returnables or non-returnables).

(III) The level of the unpriced external costs generated by carbonated beverage containers under different policies and scenarios. Section 4.3.2(ii) showed that this information will be an important input into the evaluation of beverage container policies.

4.4.2 The trippage of returnable bottles

It was evident throughout section 4.3 that the trippage of a returnable bottle is of fundamental importance in a social appraisal of the alternative returnable and non-returnable beverage containers. On account of this importance, some additional research on trippage was also undertaken and the results of this study are presented in Part V, Chapter 10, of this thesis. This trippage study examines three major questions concerning returnable beverage containers:-

(I) What are the trippage rates that are currently achieved in the U.K. and in overseas beverage markets?

(II) What are the important factors that determine the trippage and life of a returnable bottle? The examination of this question will indicate whether or not the consumer currently finds it inconvenient to return bottles to the shops. Hence, this will aid the assessment of whether or not there is any lack of consumer sovereignty in the market for beverages since it will provide information on the points (iii) and (iv) identified in section 4.3.1.(i). This will also assist in the identification and evaluation of measures which could increase consumers' welfare by reducing any inconvenience of returning bottles.

(III) How can the trippage of the returnable bottle be raised?

Section 4.3.2 demonstrated that the trippage of a returnable bottle will be an important factor determining the size of the economic and environmental impacts of a policy measure. Therefore, this trippage study, especially in respect of questions (II) and (III) above, could form a useful input into the formulation of a beverage container policy.

4.4.3 Limitations of the coverage of this thesis

Thus, this thesis covers some of the important areas and questions which were identified in the earlier sections and could thereby constitute a useful input into a social appraisal of beverage containers. However, it should be noted that this thesis is designed to act as an aid and input into the evaluation of beverage container policies. The thesis does not specify and formulate an 'optimum' policy measure, since it was not possible to undertake a full policy evaluation. Such a complete policy evaluation would have required a considerable amount of confidential information concerning the (in some cases hypothetical) impacts of the alternative policy instruments on the various sectors of the beverage industry. It would not have been possible to obtain this information, especially since the beverage industry was already subject to considerable demands and questionnaires for information from the study teams for the Waste Management Advisory Council[(13)]. Therefore, on account of these data collection problems and the need to avoid wasteful duplication of effort and to make the best use of the limited resources available for studying this complex issue, it was necessary to limit the scope of this investigation. After discussions with representatives of industry and government officials, it was considered more worthwhile to concentrate the research on collecting the original data required on the particular areas identified in sections 4.4.1 and 4.4.2 above. In this way, the research could then form a valuable

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(13) Some detailed information on the economic and environmental impacts of various policies is contained in the Waste Management Advisory Council's report [WMAC (1980)]. The OECD report [OECD (1978)] also gives a comprehensive review of the impacts of the beverage container policies that have been implemented in various OECD countries.

contribution to the current assessment of returnable and non-returnable beverage containers in the U.K.

The thesis does not examine one particular policy measure that has been proposed - the promotion of recycling. This subject has been extensively studied in two recent OECD reports [OECD (1978, 1983)].

Similarly, it was decided not to undertake any original research into the energy and raw materials requirements of the various U.K. beverage container systems, since these aspects were already being investigated in detail for WMAC by a group of expert energy analysts at the Open University, Dr. Boustead and Dr. Hancock. Their results are reported in Boustead and Hancock (1981) and are summarised in WMAC (1980). In addition, the OECD report [OECD (1978, pp.67-84)] gives a comprehensive review of many energy analyses of beverage container systems that have been performed in Europe, the USA and Canada.

This thesis does not attempt to analyse all the aspects of the other possible imperfection in the packaged beverage market - the question of consumer sovereignty. Nevertheless, the trippage study provides some information on two important aspects of this question. Some information on the remaining factors is presented in Ontario Solid Waste Task Force (1974), Ontario Waste Management Advisory Board (1976), Bate (1976) and WMAC (1980).

4.5 A general methodology for an empirical analysis of the external costs of carbonated beverage containers

In developing a general methodology for an empirical analysis of the external costs of beverage containers, it is useful first to state more elaborately this study's objectives, which are the assessment of:-

(I) The significance of the external costs of beverage containers. This will be represented by expression 4.19 below.

$$\begin{aligned} TEC = {} & \lambda_{SW}(SW_{RB} + SW_{NRB}) \\ & + \lambda_{L}(L_{RB} + L_{NRB}) \\ & + \lambda_{EP}(EP_{RB} + EP_{NRB}) \\ & + \lambda_{H}(H_{RB} + H_{NRB}) \\ & + \lambda_{U}(U_{RB} + U_{NRB}) \end{aligned} \qquad 4.19$$

where the terms above are as defined earlier in expression 4.7.

(II) The relative levels of the external costs generated by the alternative container systems.

(III) The external costs generated by the beverage container systems under different scenarios.

This thesis examines five major questions concerning the external cost areas (i)-(v) identified in section 4.4.1.

(1) Whether the impacts in these areas constitute 'potentially' relevant external costs and, if so, in what way?

The existence of any 'potentially relevant' externalities would result in a divergence between the current market position and the social optimum. Therefore, the thesis first examines whether the impacts in each of these areas constitute 'potentially relevant' external costs. This examination is performed in the light of the distinction between internal and external costs. This includes a brief assessment of the effects of any current government controls relating to each area. This analysis is designed to indicate whether producers and consumers already take into account the impacts in their production and consumption decisions concerning beverage containers and ,if so, to what extent. Any such internal element would then not be included in the external costs studied in this thesis.

(2) What is the nature and significance of these external cost areas?

This concerns the assessment of the overall external costs in these areas (i.e. the terms λ_{SW}, λ_{L} etc. in expression 4.19 above).

(3) What is the physical size of the external impacts of beverage containers?

This concerns the terms $(SW_{RB} + SW_{NRB})$ etc. in expression 4.19 . The thesis presents some data on physical indicators such as the total quantities of solid waste generated by beverage containers or the number of public health complaints received concerning beverage containers. In addition, the thesis gives an indication of the size of the beverage containers' contribution to the total level of the external costs generated in each of the five areas. This information then enables the impacts of beverage containers to be viewed in the context of the overall national position for each external cost area.

(4) What is the significance of the external costs of beverage containers?

This concerns the terms $\lambda_{SW}(SW_{RB} + SW_{NRB})$ etc. in expression 4.19 . This section draws on the information relating to questions (2) and (3). Where data are available on the financial costs incurred by the authorities for the control of the externalities, these data are converted into terms of the unit external abatement costs of an individual returnable bottle, non-returnable glass bottle and metal can.

The assessment of the unit external abatement costs raises an interesting point which has not previously been discussed in the literature concerning the beverage container issue, to which it is particularly relevant. This point is whether the average or the marginal abatement cost is the appropriate measure for the calculation of the unit external costs of beverage containers. In the particular context of solid waste, chapter five examines whether, since the integral activity, such as the generation of domestic waste, creates external costs equal to the average costs of waste disposal and collection, then does a particular component of this integral activity also generate external costs equal to these average costs per tonne; or are the external costs of a particular product equal to the marginal costs of collecting and disposing of that particular product. As yet, this question has not been resolved and not even faced neither in the present literature nor in the political forum. On account of this apparent uncertainty, the unit external costs of beverage containers are presented on the basis of both average abatement costs, wherever cost data were available, and also marginal abatement costs, wherever it was possible to derive an estimate for this. However, only marginal cost figures are used to calculate the changes in the authorities' abatement costs arising under the various scenarios outlined in section (6) below.

In addition, consideration is given to the environmental impacts of the control techniques currently operated by the authorities and the residual external impacts of beverage containers that are not controlled by the government's regulation activities.

(5) Whether the returnable system generates more or less external costs than the alternative non-returnable systems?

The thesis identifies the relative levels of external costs generated by the major alternative container systems (returnable bottle, non-returnable glass bottle and metal cans). This yields an external cost ranking of these containers for each of the five areas of external costs. For some important external cost areas, the ranking of the returnable bottle depends crucially upon the trippage achieved by this bottle. Therefore, for these areas, the thesis also presents the break-even trippages that the returnable bottle has to achieve to generate less external costs than each of the alternative non-returnable container systems.

(6) What is the level of the external costs generated by the beverage container systems under different (policy-induced) situations in the market for packaged beverages?

On the basis of a review of the U.K. and overseas literature on beverage containers, nine scenarios have been drawn up. These scenarios are outlined below and are summarised in Table 4.1.

There are two points which should be highlighted concerning these scenarios. First, the scenarios

Table 4.1 **Values used for the variables in the scenario analysis**

	SCENARIO	'OFF' Premise sales of beer, cider and carbonated soft drinks in millions of litres and as a % of total packaged 'off' premise beverage sales						'OFF' Premise Trippage
		Non-returnable Glass bottle		Non-returnable Metal Cans		Returnable Bottle		
		Vol.	(% of Σ)	Vol.	(% of Σ)	Vol.	(% of Σ)	
I.	1977 SITUATION	348	(17%)	935	(45%)	800	(38%)	4
II	NO ACTION SITUATION for 1982	511	(20%)	1375	(52%)	730	(28%)	3
III	100% Non-returnable system	1129	(43%)	1487	(57%)	0	(0%)	not applicable
IV	Market shares and trippage achieved by the returnables in 1977 (1)	418	(16%) (1)	1214	(46%) (1)	984	(38%) (1)	4
V	Intermediate increase in returnables' market share - higher trippage	313	(12%)	843	(32%)	1460	(56%)	6
VI	Intermediate increase in returnables' market share - Lower Trippage	313	(12%)	843	(32%)	1460	(56%)	3
VII	FOE post-mandatory Deposit situation	0	(0%)	943	(36%)	1673	(64%)	10
VIII	100% Returnable system	0	(0%)	0	(0%)	2616	(100%)	10
IX	100% Returnable system - Higher trippage	0	(0%)	0	(0%)	2616	(100%)	15

(1) The market shares in 1977 between the different containers for each beverage (i.e., beer, cider and carbonated soft drinks) have been used in scenario IV for 1982. However, the aggregate market shares shown above for scenario IV are not exactly the same as the aggregate market shares in 1977 on account of differences in the sales growth rates between 1977 and 1982 for the different beverages.

relate to the 'off' premise sales market for beverages, since the OECD report [OECD (1978, p.38)] notes that:

> "any beverage container policy measure will primarily be directed to the 'off' premise market".

Second, it has been necessary to limit the number of variables analysed in the scenarios in order to facilitate the identification of some conclusions concerning the external costs of beverage containers. There are two important determinants of the external costs of beverage containers which could be altered by a policy measure. These are the market shares of the alternative containers and the trippage of the returnable bottle. Therefore the scenarios I-IX analysed in this thesis incorporate the following assumptions concerning these two factors:-

(I) Scenario I is the sub-division of the 'off' premise beverage market between the alternative containers in 1977. An estimate of four has been assigned for the returnable bottle's 'off' premise trippage under this scenario (see Table 4.1)

(II) Scenario II is the situation in the beverage market that is predicted to occur in 1982 if there is no action or intervention by the government. This 'No-Action' situation is the baseline against which to compare the outcome following any government policy measure. The OECD report [OECD (1978)] emphasised that a policy should be phased in gradually in order to reduce its economic impacts on the beverage industry. The WMAC report [WMAC (1980)] states that the industry would require a 5-year phasing-in period. Therefore, 1982 was chosen as the year in which a policy measure, originally implemented in 1977, would become fully effective. The forecasts of the sub-division of the 'off' premise beverage market between the alternative containers in 1982 are shown in Table 4.1. These forecasts of an increased use of non-returnables were derived from the WMAC report [WMAC (1980)] and from data and information supplied by Metal Box. Appendix II gives a detailed breakdown of these forecasts. The trippage achieved by the returnable bottle has been falling in recent years [Glass Manufacturers Federation (1973), Fisher and Horton (1979)]. Therefore, the trippage is assumed to decline further to 3 in 1982.

(III) Scenario III is the extrapolation of the present trends to the extreme case where the non-returnable bottle and can completely replace the returnable bottle whose market share falls to zero.

(IV) Scenario IV is similar to scenario I in that it assumes that the returnable bottle maintains the market share and trippage achieved in each of the beverage markets in 1977. The difference, between scenarios I and IV, is that scenario IV applies to the larger 'off' premise market forecast for 1982.

(V) Scenario V depicts an intermediate increase in the market share of the returnable bottle whose trippage rises to 6.

(VI) Scenario VI is similar to the intermediate scenario V. However, under scenario VI, the returnable bottle's trippage does not increase but remains at the baseline scenario II level of 3.

(VII) Scenario VII is based upon the scenario proposed by Cawdell in Friends of the Earth's minority report to the waste Management

Advisory Council [Cawdell (1980)]. This scenario is the predicted outcome in the carbonated beverage market after the implementation of mandatory deposits. This comprises an increase in the market share of the returnable bottle, whose trippage is also assumed to rise. This assumption of an increase in the returnable bottle's trippage is based upon the experience overseas (e.g., Oregon), where trippages rose after the implementation of such measures [see Gudger and Walters (1976)]. The non-returnable bottle's market share falls to zero and the can's share falls.

(VIII) Scenario VIII is a completely 100 per cent returnable system. A trippage of 10 has been assigned for this scenario.

(IX) Scenario IX also depicts a 100 per cent returnable system but a higher trippage of 15 has been assigned for this scenario.

Additional scenarios adopting different assumptions for these factors could be analysed. However, this would produce an excessive mass of data which would make it difficult to see clearly the significant points concerning the results. Therefore, additional scenarios have not been included in this thesis. Nevertheless, the detailed data for scenarios I - IX presented in Appendix II could still be used by an analyst to assess the environmental impacts of beverage containers under additional scenarios.

All the scenarios II-IX above have been assigned the same level of total 'off' premise beverage sales. This assumption of constant sales was used in Cawdell's minority report [Cawdell (1980)]. It was also adopted in this thesis so as to highlight the effect upon external costs of changes in the market shares between returnables and non-returnables and changes in trippage rates, as distinct from the decrease in external costs that would result from a reduction in the overall sales level of packaged beverages.

The calculations for the analysis of the various scenarios is based upon the information obtained concerning the questions identified earlier.

General considerations concerning the application of the methodology

Methologies applied and proposed

Table 4.2 identifies, with a x, the methodologies adopted in this thesis for the evaluation of the external costs of beverage containers. These are termed the 'best practicable' methodologies since they are the best assessment procedures that could feasibly be followed in the light of the data constraints encountered during the performance of the research. In addition, Table 4.2 identifies, with a ✓, the 'best available' methodologies that should be followed if a more elaborate (economic) valuation should be required and if more adequate resources and information were available for this(14). The details of these methodologies are

(14) These terms 'best available' and 'best practicable' are being used in this thesis in a manner that it analogous to their meaning in relation to pollution controls in the U.S. Thus, in the U.S., the 'best available' technologies are the best techniques that are currently available for reducing pollution emissions from a plant; while the 'best practicable' technologies are the best pollution control technologies that could feasibly be implemented at a particular plant. In determining the best practicable technologies, greater consideration is given to the practical problems and economic costs associated with the implementation of the alternative pollution control techniques.

Table 4.2 Techniques for the evaluation of the external costs of beverage containers, under the 'Best Practicable' Methodology(✗) and a 'Best Available' Methodology(✓)

Environmental Impact Category	Physical Impact Studies: Physical Quantities Generated	Physical Impact Studies: Impacts – Order of Magnitude	Physical Impact Studies: Impacts – Data	Qualitative Assessment: Type and Nature of Impacts	Qualitative Assessment: Significance of Impacts – Experts' Opinion	Qualitative Assessment: Significance of Impacts – Public Opinion Polls	Economic Evaluation: Abatement Expenditures – Ball park 'Guesstimates'	Economic Evaluation: Abatement Expenditures – Detailed Data	Economic Evaluation: Consumer Surveys – Single Impact area	Economic Evaluation: Consumer Surveys – Overall Evaluation	Adoption of Available Valuations
i) Domestic Solid Waste											
– Municipal waste management	✗							✗			
– Environmental impacts of current waste management techniques											
– Landfill Sites	✗		✗ (But limited)	✗	✗			✓	✓		
– Others	✓		✓	✗	✗				✓		
ii) Litter											
– Public & private litter collection & control	✗(1)						✗	✓			
– Impacts of residual litter											
– Injuries	✗(1)		✓	✗	✗		✗ (overseas data)	✓	✓		
– Eyesore	✗(1)	✓		✗	✗	✗			✓		
iii) Pollution											
– Air pollution	✗(2)		✓	✓	✗						✓
– Water pollution	✗(2)		✓	✓	✗						✓
– Industrial solid wastes	✗(2)		✓	✓	✗						✓
iv) Public Health & Hygiene											
Contaminants											
– Public controls	✗						✗	✓			
– Residual impacts	✗	✗		✓					✓		
Sanitation at Shops											
– Public controls	✓							✓			
– Residual impacts		✗	✓	✗	✗				✓		
v) Transportation Impacts											
– Road track costs	✓		✓	✓			✓				✓
– Accidents	✓		✓	✓							✓
– Noise	✓		✓	✓							✓
– Vibration	✓		✓	✓							
– Congestion	✓	✗	✓	✗	✗				✓		✗ (But just guess-timates) ✓

Notes

(1) The data come from a limited number of surveys which indicate the contribution of carbonated beverage containers to the total amount of litter discarded but cannot yield a measure of the number of beverage containers that are littered annually.

(2) The pollution data are based on studies performed in other countries (see text)

discussed in each chapter. Some general points concerning these methodologies are presented here.

These methologies have been drawn up on the basis of the general principles developed in the previous chapter. Thus, a sequential approach has been applied and the extent to which the various sequential stages of the analysis have been followed through has depended upon : the importance of the impacts of beverage containers in each area; the data that was available; and the ease or difficulty with which additional data could be obtained.

A review of the literature and meetings with the Steering Group of the Waste Management Advisory Council revealed that domestic waste and litter were the two areas of external costs where the impacts of beverage containers were likely to be most important [e.g., see Lidgren (1976), (OECD (1978)]. During the research activity, attention was accordingly concentrated on obtaining information on these two areas. Therefore, many of the sequential stages in the valuation of these external costs of beverage containers were accomplished and the questions (1)-(6) outlined above are analysed in detail. Thus, Table 4.2 shows that a full economic evaluation has been undertaken regarding municipal waste management expenditures. However, in relation to litter, considerable data collection problems were encountered which precluded the performance of such a thorough and precise economic evaluation of litter collection and control expenditures.

It was not feasible to undertake an economic evaluation for the environmental impacts of the waste management techniques currently adopted (e,g, water pollution run off and unsightliness at a sub-standard landfill site) and for the injuries and aesthetic impacts of littered bottles and cans. Therefore, for these impacts and also for the other areas (air and water pollution emissions, hygiene and urban traffic congestion), it was only possible to perform the first stages in the sequential analysis. Thus, Table 4.2 shows that the assessment of these unquantifiable impacts comprises a presentation of physical information on these impacts (e.g., the quantities of pollutants generated, the number of cases of contaminants being found in beverage containers etc.), supplemented by qualitative information on the nature and significance of these impacts (e.g. the type and seriousness of these cases). The latter aspect is based principally upon a review of the opinions of the authoritative bodies engaged in the regulation of these areas and the results of public opinion surveys regarding some of these impacts. In addition, some 'ball park' maximum 'guesstimates' are presented on the congestion costs arising from beverage deliveries and the public costs of investigating complaints concerning contaminants in beverage containers. These 'guesstimates' substantiate the qualitative analysis' findings of the low significance of carbonated beverage containers' impacts in these areas.

Beverage container policies would lead to some impacts that could be presented in monetary terms, and also a wide variety of impacts that could not be valued in monetary terms. For example, action to favour returnables would yield economically quantifiable environmental benefits (such as reductions in waste management costs), along with unquantifiable environmental benefits in the form of less litter, reduced air and water pollution emissions and less industrial solid wastes. While such a policy would also lead to unquantifiable environmental costs, such as increased traffic congestion and more sanitation problems at some retail outlets. Thus, there would be a myriad of unquantifiable environmental impacts occurring on both the benefits and costs side. Consequently, it was not feasible to draw up contingency values for the diverse unquantifiable environmental cost and benefit items.

The WMAC considered that beverage containers constituted a small and separable part of the overall external costs relating to air and water pollution, hygiene and urban traffic congestion, so that it was not worthwhile analysing in any depth the overall problem concerning these three areas. Therefore question (2) was not investigated for these three aspects and, instead, efforts were concentrated on obtaining and presenting information on the specific external impacts of beverage containers in these areas.

In relation to question (6), data should ideally be presented for the physical quantities of the external impacts of beverage containers, which should then be multiplied by the marginal costs of these impacts to yield a quantitative monetary figure for the levels of the external costs generated by beverage containers under the different scenarios. However, in reality, this ideal is not attainable on account of the significant constraints surrounding the acquisition of the appropriate data. For only one category - domestic waste - was it possible to obtain any financial data to enable the performance of such a quantitative analysis. It was not possible to determine any monetary valuation of the air and water pollution impacts of beverage container systems so that instead some physical estimates are presented. While meaningful quantitative figures could not be derived for the other three areas of externalities (litter, hygiene and traffic congestion). Therefore, for these three areas, it is only possible to give some qualitative information indicating the direction but not the specific size nor the monetary value of the likely changes in the environmental impacts generated by beverage containers under the different scenarios. In addition, the thesis reports the opinions of the authoritative bodies on the significance of the expected changes in the hygiene and urban traffic congestion impacts of the beverage container systems.

It is acknowledged that this 'best practicable' methodology is subject to some limitations. Where such limitations and important gaps in the current knowledge are apparent, these are highlighted in the thesis, along with any uncertainties concerning the data that is presented.

In addition, Table 4.2 identifies the 'best available' methodologies that should be pursued if it was considered necessary to obtain a more accurate economic valuation of the environmental impacts of beverage containers. These 'best available' methodologies outline the more precise physical data required on the quantities of pollutants generated and the damages occurring. Further qualitative information would then be needed on the nature of these impacts (e.g. their location, and the size of the human and wildlife populations affected).

Consumer survey techniques should primarily be used to derive an economic valuation of these physical impacts, although it is also suggested that available imputed monetary values should be used for some of the transportation and pollution impacts (see Table 4.2). These imputed values are the figures for aspects, such as the value of an accident and the value of time, which are published and used in government studies. Imputed figures for other impacts, such as the value of human life and the economic value of pollution damage, could be derived from reviews of the empirical information on these subjects [e.g. see OECD(1983)]. It is acknowledged that these adopted values could not represent perfect measures since they are subject to some limitations which would have to be highlighted. In particular, in their derivation from the available empirical studies, consideration would have to be given to the adopted valuation techniques' limitations, which were discussed in chapter 3. Nevertheless, these imputed values are readily available and some credence can be attached to them. The rough estimates generated by their use are probably sufficient for the purposes of studying this particular subject, especially since the basic physical data cannot be as accurate as is ideally required. The decision to use this procedure would largely be a matter of the allocation of research effort. Original research activity should thus primarily be directed towards performing appropriate consumer surveys for those important impacts items on which little monetary valuations are currently available (e.g. litter).

Consumer survey techniques could perhaps also be used to derive an overall evaluation of the quantifiable and unquantifiable impacts. This would best be done in conjunction with information on the economic impacts of beverage container policy measures in the policy evaluation so that any important trade offs between certain economic and environmental impacts could then be analysed. Thus it might be worth considering the use of a Hoinville type priority evaluation approach for this with the respondent selecting between different economic and environmental impact items. The evaluations performed under the 'best available' methodology could be used to yield the appropriate information provided for the respondents on these impacts and to specify the units of the separate impact items (e.g., X% more littered bottles and cans, £mY of savings in the authorities' waste disposal costs, beverage prices lower by Z%, P jobs gained in certain industries and Q jobs lost in other industries, etc.).

The 'best practicable' methodology applied in this thesis principally involves the use of U.K. experience and data, since information from other countries may not be directly applicable to the particular situation in the U.K.

and on account of the resulting need expressed by WMAC for a U.K. decision on the beverage container issue to be based upon U.K. data. However, for air and water pollution emissions, it was not feasible to obtain sufficient U.K. data. Therefore, overseas data had to be used for the analysis of this area. This should give a reasonable indication of the relative air and water pollution emissions generated by the alternative beverage container systems. Nevertheless, this overseas data does have certain limitations which are acknowledged and identified. Moreover, a 'best available' methodology is developed for the acquisition of the relevant U.K. data if it was still considered necessary to provide actual U.K. data for this area. Furthermore, this is supplemented by the presentation of two case studies in Appendix VI, which indicate how this methodology might be employed in practice.

4.6 Conclusion

This chapter has highlighted the wide range of alternative policy measures concerning beverage containers that have been implemented or proposed in a number of countries. This wide range of policy options enhances the need for a sound framework for an analysis of this particular issue. Accordingly, in section 4.3, a conceptual framework is developed for a social appraisal of beverage containers.

It is shown that the criteria for the government to consider intervening in the beverage container market comprise: the existence of imperfect information and a lack of consumer sovereignty in the packaged beverage market; the existence of any potentially relevant external costs of beverage containers; and the beverage container systems' consumption of finite resources which are considered to be incorrectly priced under the current market mechanisms.

Section 4.3.2 then goes on to set out some criteria for the next stage of the social appraisal - the evaluation of the alternative policy measures. This details the specific environmental and economic impact items that need to be considered in the evaluation of the policy measures. The existence of possible overlapping between some of the economic impact items is pointed out and this section demonstrates how to avoid any double counting that might otherwise arise.

Section 4.4 outlines the scope of this thesis which is to study the external costs of carbonated beverage containers and the trippage of the returnable bottles. On the basis of the theoretical foundations for the evaluation of environmental damage costs, developed in the previous chapter 3, the final section 4.5 then outlines the 'best practicable' methodology that is now followed for the evaluation of the external costs of carbonated beverage containers in the next five chapters. It is acknowledged that this methodology is subject to some limitations which are primarily due to the practical constraints surrounding the collection of the appropriate data. Therefore, the last section also outlines a proposed 'best available' methodology that could be followed for the economic evaluation of the environmental impacts of carbonated beverage containers, if it should be necessary to seek further information.

P A R T I V

THE EMPIRICAL ANALYSIS OF THE EXTERNAL COSTS OF CARBONATED BEVERAGE CONTAINERS

CHAPTER 5

DOMESTIC SOLID WASTE

Introduction

Concern over the rising quantities of domestic solid waste has prompted interest and investigations concerning one particular component of the solid waste stream: beverage containers; thus a government official has stated that[1]:

> "During the '60s, private citizens, public interest groups and governments became increasingly concerned about the rapidly increasing quantities of litter and wastes being generated. The beverage container came to the forefront,....because it had clearly and quantifiably changed from being refillable to being non-refillable and this trend to throw away packaging appeared to be growing."

Similarly, Lidgren (1976, p.13) notes that:

> "waste as such constitutes a special environmental problem...... Since different packages can give rise to waste treatment costs of one kind or another there is still good reason, notably from the recovery aspect, to discuss packages in terms of waste."

Therefore, this chapter reviews the impacts arising from the disposal of beverage containers in domestic solid waste.

- Section 5.1 examines the 'external' nature of the costs arising from the generation of domestic solid waste.
- Section 5.2 outlines the 'best practicable' methodology that is followed in this chapter for the evaluation of these external costs. This section also develops a 'best available' methododology that could be used for the

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(1) Source: Personal communication with officials of the Solid Waste Management Branch of Environment Canada.

performance of a full economic evaluation of these external costs if this should be considered necessary and if more resources were available for the acquisition of the additional data and information required for this.

- Section 5.3 presents a detailed review of the currently available information on the external costs of domestic solid waste.
- Section 5.4 then assesses the size of the beverage container component of domestic solid waste.
- Section 5.5 analyses the ranking of the alternative beverage containers in terms of their relative levels of domestic waste generation.
- Section 5.6 uses the information presented in sections 5.3-5.5 to evaluate the external costs of the domestic solid waste generated by returnable and non-returnable beverage containers.
- In Section 5.7, this information is then used to estimate the quantities of beverage containers in domestic waste and the external costs of their collection and disposal under various scenarios for the beverage container market in 1982.

5.1 The 'external' nature of the costs arising from the generation of domestic solid waste

The generation of domestic solid waste results in two types of social costs:-

(i) the financial costs incurred by local authorities to collect and dispose of domestic waste;

(ii) the environmental impacts of the waste management techniques currently operated by local authorities (e.g., air pollution from an incinerator or water pollution run-off and unsightliness at a landfill site).

The external nature of both of these categories of impacts has been advocated not only by economists [e.g., see

Grace (1977)] but also by engineers engaged in solid waste management [e.g., see Higginson (1971), Gosling (1973)]. The latter category constitutes external costs since these environmental impacts on other residents are not taken into account by the householders generating the waste. The financial costs of domestic waste collection and disposal do also constitute external costs because, even though these costs are borne by tax paying householders, they are paid by householders in a flat rate manner (usually a levy on the rates) that is not directly related to the quantity of solid waste generated by the householder. This flat rate payment system gives the individual householder no incentive to reduce the quantity of solid waste he/she generates. Therefore, under the current system, the consumers - and hence also the producers - have no incentive to take into account the costs of domestic waste management and the waste disposal characteristics of products. Thus the social costs arising from the disposal of products as domestic waste are 'external' to the householder at the point when he/she purchases the products(2).

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(2) It had been suggested that the sales and excise taxes currently levied on beverages result in the internalising of the costs of waste disposal and collection. However, this is not the case since the sales and excise taxes are levied on the contents and not the package of the beverage; while it is the package, not the contents, that results in the generation of solid waste. Moreover, the levels of domestic waste generated by the alternative packages for beverages can be significantly different. Thus, the domestic waste generated by draught (bulk) sales of beverages is very much less than that from bottled and canned beverages, although the level of sales and excise taxes on the beverages would be the same for both types of packaged beverages.

5.2 Methodologies for evaluating the external costs of carbonated beverage containers in domestic waste

The sequential approach is applied in this chapter for the evaluation of the external costs of domestic solid waste. The extent to which the sequential stages have been followed through in this analysis differs for the two different categories of external costs, identified in the previous section.

A full economic evaluation is made of the first category - the authorities' financial costs of collecting and disposing of domestic waste. The thesis presents estimates of the physical quantities of solid waste generated in the U.K. and the available data on the authorities' waste management costs are then detailed. An in-depth analysis of the data is undertaken to derive estimates of the economic costs of domestic waste collection and disposal. In addition, information from a number of sources is used to determine the marginal costs of domestic waste management.

The evaluation of the second category - the environmental impacts of current waste management techniques - would entail a series of steps. The first step would be the identification of the types of environmental impacts involved. It would be worthwhile to treat separately the impacts of landfill sites from those of the other techniques, since the landfill sites' impacts appear to be more important and are more wide ranging. Thus, these impacts include the water pollution problems caused by leachate from a site, as well as nuisance to neighbouring residents caused by flies, vermin and unsightliness of the site. The impacts of the other techniques primarily comprise nuisances to nearby residents (e.g. air pollution emissions from an incinerator).

For the evaluation of the water pollution problems, information is ideally required on the total quantities of leachate effluent generated by landfill sites, the propinquity of the landfill sites to aquifers and surface waters, and the cases of the leachate contaminating aquifers and surface water bodies. This last aspect would pose the considerable problem of identifying where contamination of aquifers has occurred and determining the extent to which such contamination was caused by leachate from landfill sites. A monetary valuation of these cases would include the water authorities' costs of purifying the contaminated water or providing water from alternative sources. In addition, any residual deterioration in the quality of the water supplies would have to be assessed. Physical indicators would be required of any pollution of surface waters, and consumer survey techniques could then be used to evaluate these impacts.

The nuisance impacts of landfill sites and other waste management techniques could be assessed by determining the proximity of residential areas and then performing opinion surveys of the households in the affected areas. Care would have to be taken to ascertain the types of impacts that were perceived and valued by the respondent so as to ensure that there was no doublecounting in relation to the impact items for which valuations could be determined separately (e.g. the financial costs of waste management and the water authorities' costs of purifying water supplies).

This 'best available' methodology for the second external cost category could not be followed in this thesis since there is a lack of nation-wide information on the items identified above and sufficient resources were not available to undertake the extensive site-specific research required to obtain this information. Consequently, the analysis of this aspect is limited to the first step - identification of the types of environmental impacts created by current waste management techniques - and a review of the available information on these impacts. This comprises some quantitative estimates of the total effluent from landfill sites, supplemented by a qualitative indication of the frequency and significance of the contamination of aquifers and surface waters by leachate from landfill sites. In addition, some qualitative information is presented on the significance of the aesthetic impacts of landfill sites upon neighbouring residents. In the light of the current lack of data, the problems involved in obtaining the additional information ideally required and the relatively low importance of this aspect in the context of a beverage container study, the procedure outlined above represents the 'best practicable' methodology that could be adopted for assessing this aspect. If more detailed information should be required and if more resources were available for its acquisition, then the 'best available' methodology developed earlier could form the basis for this.

5.3 Review of available data on the external costs of domestic solid waste

5.3.1 The financial costs of domestic waste collection and disposal

The local authorities' net costs of waste collection and disposal in the U.K., amounted to £291.95m. and £104.2m., respectively, in the financial year 1976-77, (1977 prices) [Chartered Institute of Public Finance and Accountancy (CIPFA) (1977), Society of County Treasurers (SCT) (1978a)]. The 'net' cost figures given above indicate the financial burden to the local authorities arising from their collection and disposal of waste. The above figures are 'net' of the local authorities' income from waste disposal and collection charges and from the sale of recycled materials. In 1976-77, the authorities' income from these sources amounted to about £31.2m (1977 prices) [CIPFA (1977), SCT (1978a)]. Therefore, in 1976-77, the local authorities' 'gross' costs of waste collection and disposal were about £312m and £115.4m, respectively (1977 prices) [CIPFA (1977), (SCT(1978a)]. The 'gross' costs of waste collection and disposal in 1977-78 were about £310m and £116m, respectively (1977 prices). The waste disposal authorities' income was estimated to be about £10.9m in 1977-78, so that the 'net' costs of waste disposal in 1977-78 were about £105.4m (1977 prices). Similar data for the waste collection authorities' income are not available for 1977-78. Nevertheless, if the data for 1976-77 from CIPFA (1977) are used, then it can be estimated that the 'net' costs of municipal waste collection in 1977-78 were about £287.8m (1977 prices).

These costs represent about £7.10 per head of the population. According to the CIPFA (1977) report, the 'net'(3) municipal wastes amounted to about 18.0 million tonnes in 1976-77. Thus, the average costs of waste collection and disposal were about £16.20 per tonne and £5.80 per tonne, respectively in 1976-77 (1977 prices). The data for 1977-78 indicate that the average costs of waste collection and disposal were about £15.70 per tonne and £5.80 per tonne, respectively, in the financial year 1977-78. However, there are four major points that must be highlighted concerning these estimates.

First, Figure 5.1 shows that local authorities collect waste not only from households (16.0 million tonnes per annum) but also from the commercial sector (about 2.2m tonnes per annum) [CIPFA (1977)]. Local authorities charge commercial premises for the collection of their waste. In 1976-77, these charges amounted to about £15.6m (1977 prices) [CIPFA (1977)]. This is equivalent to a charge of about £7 per tonne of commercial waste collected. It was not possible to determine whether this charge covers the local authorities' costs of collecting waste from commercial establishments, which may be lower than the average costs of collecting wastes from households on account of the larger quantities of wastes generated at commercial establishments.

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(3) The 'net' municipal wastes are the 'gross' amount of household and commercial wastes collected by the local authorities [about 18.23 million tonnes in 1976-77 CIPFA (1977)], less the quantity of waste that is recycled by the waste collection and disposal authorities [about 0.28 million tonnes in 1976-77 CIPFA (1977), SCT (1978a)].

If these charges cover the authorities' cost of collecting commercial waste, then an estimate for the average costs of collecting domestic waste should be derived by dividing the 'net' costs of waste collection by just the above figure for 'net' household wastes (16.0m tonnes). This yields an estimate for the 'net' average costs of domestic waste collection in 1976-77 of about £18.4 per tonne (1977 prices). However, if the charges do not fully cover the costs of collecting commercial waste, then the average costs of domestic waste collection would be less than this figure of £18.4 per tonne.

Second, Figure 5.1 shows that the County Council's waste disposal authorities (WDAs) administer about 9.1 million tonnes of delivered wastes (primarily from commerce and industry) as well as the 18 million tonnes of domestic and commercial waste collected by the local authorities. The WDAs may charge for the disposal of these delivered wastes, depending principally upon what they are. Material such as rubble, which is actually useful as cover material at landfill sites, may be allowed in free; while fees may be charged for the disposal of awkward wastes. In 1976-77, waste disposal charges for delivered waste amounted to about £7.4m [1977 prices) (SCT (1978a)]. The earlier estimate of £5.80 per tonne for the average costs of waste disposal was derived by dividing the WDAs' 'net' costs of waste disposal (£104.2m) by the estimate for the household and commercial wastes collected by the local authorities (18 million tonnes). However, if the WDAs' 'net' annual costs plus the charges, (i.e., the WDAs' costs of disposing of all of the waste they administer, a total of £115.4m in 1976-77) is

Figure 5.1

Sources and amounts of wastes collected and disposed annually in the U.K. by the local authorities - in millions of tonnes (1976-77 data)

COLLECTED MUNICIPAL WASTE			DELIVERED WASTE
DOMESTIC	COMMERCIAL		
16.0	2.2		9.1
'Gross' municipal waste collected	= 18.23		
Waste recycled	= 0.16		
'Net' municipal waste collected	= 18.07		
Total Gross Wastes administered by the Waste Disposal Authorites (WDAs)		= 27.17	
Waste Recycled		= 0.12	
'NET' wastes disposed		= 27.05	

Sources: Chartered Institute of Public Finance and Accountancy (1977)
Society of County Treasurers (1978a)
Metal Box Market Research Division

(1) The data for collected municipal waste comes from the Chartered Institute of Public Finance and Accountancy (CIPFA) report (CIPFA (1977). The data for delivered waste comes from the Society of County Treasurers' report [(SCT (1978a)]. The figures in these reports were grossed up for the U.K. on a per capita basis using population data from the Office of Population Censuses and Surveys and the General Register Offices (Scotland and Northern Ireland).

(2) The sub-division of total municipal waste between domestic (88 per cent) and commercial waste (12 per cent) was derived from data presented in the CIPFA report [CIPFA (1977)].

divided by the total wastes they administer (27.2 million tonnes p.a.), then this yields an estimate for average waste disposal costs of £4.20 per tonne. The choice between these two estimates depends upon whether the charges levied on delivered wastes cover the costs of their disposal. The income raised by the charges in 1976-77 was equivalent to an average charge of 0.80p. per tonne of delivered waste (1977 prices). It has been suggested that these charges may not cover the costs of disposing of delivered wastes so that the average costs of domestic waste disposal could be less than the estimate of £5.80 per tonne, reported earlier.

The third point, relating to the figures derived earlier for the average costs of waste collection and disposal, is that there is considerable controversy concerning the denominator - the total level of municipal wastes generated annually in the U.K. Estimates for this range from 15.5 to 19.5 million tonnes per annum. [Department of the Environment (DOE) (1971, 1973), Tanner (1974), CIPFA (1977), SCT (1978a)]. The figure of 18.0 million tonnes given by the local authorities' data in the CIPFA report [CIPFA (1977)] could be too high since the Department of Environment has noted that there is an apparent tendency for over-estimation of waste quantities by those local authorities who do not actually weigh their wastes [DOE (1971), CIPFA (1977)][4]. Therefore, a more accurate

(4) The Sumner report shows that the per capita and total weight of waste generated was 14 per cent lower when, instead of estimating them on the basis of all the authorities' results, they were calculated from the results of just those authorities that weighed 95 per cent or more of their waste [DOE (1971)].

figure for the total municipal wastes generated in the U.K. in 1977-78 may be about 16.0 million tonnes. Using this figure, instead of 18.0 million tonnes, the average costs of waste collection and disposal are raised by about 14 per cent.

Finally, Wilcox (1976) and Porteous (1978a) assert that the authorities' figures for the costs of waste disposal and collection underestimate the real costs of this service, since they are based on historic accounting costs and the book value of assets such as municipally owned land may not represent their full social value.

To sum up: The first, third and fourth points indicate that the actual average costs of collecting domestic waste in 1976-77 are higher than the estimates given earlier and are more probably in the region of £19-£20 per tonne (1977 prices). The last two points indicate that the earlier estimate for the average costs of waste disposal is too low, while the second point suggests that the earlier estimate is too high. In the light of these counteracting factors, it is considered that the average costs for the disposal of domestic wastes in 1976-77 lie in the range between £5.5 and £6.5 per tonne, with a mid-point 'best' estimate of about £6 per tonne (1977 prices). Similar adjustments can be made for the data relating to the financial year 1977-78. These indicate that the average costs of collecting and disposing of domestic waste in 1977-78 were about £19 per tonne and £6 per tonne, respectively (1977 prices).

5.3.2 The environmental impacts of solid waste collection and disposal

The environmental impacts of solid waste management comprise the noise and congestion created by the refuse collection vehicles, the air pollution from incinerators and the problems arising at landfill sites. These problems include the nuisance to local residents caused by the movement of traffic to and from the site and by the smells, flies, vermin, and unsightliness of the site.

The drainage of water through a landfill site produces an effluent which has a high biochemical oxygen demand of about 1,000 mg/litre. The Department of the Environment estimate that drainage from waste disposal sites accounts for about 18,600m^3 of effluent per day, or 0.4 per cent of total industrial effluent discharges (DOE 1978a). This presents a potential water pollution problem at sub-standard landfill sites about which the water authorities have expressed considerable concern [e.g., see Severn Trent Water Authority (1976)]. There appear to be few documented cases of ground water contamination arising from landfill sites [DOE (1978b)], but the Severn Trent Water Authority said that instances of landfill sites resulting in the pollution of surface water courses are fairly frequently brought to their attention [see also DOE (1976a)].

Apart from this information on water pollution, there appears to be little documented evidence at present on the other environmental impacts of landfill sites. The Sumner report stated that over 25 per cent of domestic and commercial waste was disposed in a semi-controlled or uncontrolled manner [DOE (1971)]. Cranston (1972) and Bratley (1977) report that many complaints had been made about smells, fire, vermin and fly infestation at a number of landfill sites, one of which was close to residential properties. The Local Government Operations Research Unit (LGORU) states that there is increasing public concern over the impacts of solid waste disposal (LGORU 1972a).

5.3.3 Trends and projections

5.3.3(i) Recent trends in the weight, density and volume of municipal waste generated

Table 5.1 presents data on the weight of municipal waste generated over the period 1963-64 to 1979-80. The volume of waste generated, rather than the weight, is generally regarded as being the more important measure since it is the volume of waste that primarily determines the life of the landfill site and the capacity of the refuse collection vehicles, the reception hoppers, conveyor belts and equipment at refuse treatment plants (e.g., transfer stations, incinerators, etc.). Therefore, some estimates for the density of waste have been used to convert the data into terms of the volume of municipal wastes generated over this period.

The data on the weight of municipal wastes for the years 1963-64 to 1974-75 were derived from Tanner (1974). The data for 1976-77 come from CIPFA (1977). The data for 1977-78 comes from the WDA's estimates reported in SCT (1977). The SCT's estimates are generally fairly close to the actual figures they ultimately report. The data for 1978-79 and 1979-80 come from CIPFA (1979, 1980a). These data were grossed up for the U.K. using population data given in OECD (1981). The data on the density of collected waste

Table 5.1

The weight, density and volume of municipal waste(2) in the U.K., 1963/64 to 1979/80 with forecasts for 1982-83

YEAR	Total Gross(2) Weight 10^6tonnes	(% change) (p.a.(1))	% change 1963-4 to 1978-79	Density kg/m^3	(% change) (p.a.)	% change '63-4 to '78-79	Total Gross Volume 10^6m^3	(% change) (p.a.)	% change '63-64 to '78-79
1963-64	16.3	-		200	-		81.5	-	
1967-68	16.8	(+0.8%)		160.8	(-5.3%)		104.5	(+6.4%)	
1968-69	17.3	(+2.9%)		157.5	(-2.1%)		109.8	(+5.1%)	
1969-70	16.9	(-2.3%)		142.9	(-9.3%)		118.3	(+7.7%)	
1970-71	17.0	(+0.6%)		146.2	(+2.3%)		116.6	(-1.4%)	
1972-73	17.5	(+1.5%)	9.8%	153.4	(+2.4%)	-30.8%	113.8	(-1.2%)	+59.5%
1973-74	17.7	(+1.0%)		151.5	(-1.2%)		116.8	(+2.7%)	
1974-75	17.9	(+1.1%)		161.0	(+6.3%)		111.2	(-4.8%)	
1976-77	18.23	(+0.9%)		n.a.	-		n.a.	-	
1977-78	18.5	(+1.5%)		151.7	(-2.0%)		122.0	(+3.1%)	
1978-79	17.9	(-3.2%)		138.5	(-4.5%)		130.0	(+6.6%)	
1979-80	18.0	(+0.6%)		n.a.	-		n.a.		
1982-83	18.3E	(+0.5%)		130.4E	(-1.5%)		140.7E	(+2.0%)	

Sources: Tanner (1974), Society of County Treasurers (1977), Merseyside County Council (1977), Chartered Institute of Public Finance and Acountancy (1977, 1979, 1980a), and the Department of the Environment's waste composition analyses.

1. The % changes between the figures given for the various years have been converted into terms of annual % changes.
2. The above data refer to 'Gross' municipal wastes which comprise domestic wastes (≏88%) and commercial wastes (≏12%), it does not include civic amenity waste. Time series data were not available on the level of recycling of municipal wastes to enable derivation of estimates of the 'net' municipal waste generated over this period.
3. The data refer to the financial year 1st April - 31st March (i.e., 1st April 1963 - 31st March 1964).

E = Forecast.

were obtained from the Department of the Environment's waste composition analyses and from Merseyside County Council's analysis of domestic waste [Merseyside County Council (1977)].

Table 5.1 shows that, over the period 1963-64 to 1978-79, there has been a 10 per cent increase in the weight of municipal solid waste generated and a 31 per cent reduction in the density of municipal waste. These two factors have resulted in a 60 per cent increase in the volume of municipal waste generated over this fifteen-year period. These increases are equivalent to annual increases in the weight and volume of municipal waste of 0.6 per cent and 3.2 per cent, respectively. This increase in the volume of solid waste generated has been attributed to increases in income levels, the growth in packaging and changes in households' heating systems [Millard and Flintoff (1969), Higginson (1971)].

5.3.3(ii) Forecasts for the quantities of municipal waste

LGORU [LGORU (1974)] forecast that the weight of solid waste generated per capita would continue to increase at a rate of 1 per cent per annum. However, more recent data indicate that the annual increase in the weight of municipal waste generated is lower now than it was in earlier years (see table 5.1). On the basis of these earlier forecasts and the data presented in table 5.1, an increase of 0.5 per cent per annum has been assigned for the growth in the weight of municipal waste generated[5]. The density of municipal

(5) These forecasts refer to the rate of increase in the total amount of municipal waste generated, not to the amount of waste generated per capita.

waste has been assumed to decline at a rate of 1.5 per cent per annum up to 1982-83. This is lower than the rate of decline recorded between 1963-64 and 1978-79 (2.4 per cent per annum) to allow for the probably diminishing effect of the factors causing the recent decline in the density of domestic waste (e.g., changes in households' heating systems). Accordingly, the volume of solid waste generated has been predicted to increase at an annual rate of 2 per cent per annum so that the volume of municipal solid waste generated in 1982-83 is expected to amount to about 141 million cubic metres (see Table 5.1).

5.3.3(iii) Recent trends in waste collection and disposal costs

Table 5.2 shows that, over the period 1963-64 to 1979-80, there has been a 979 per cent increase in the authorities' waste disposal and collection costs. This is equivalent to an annual increase of 16 per cent. In Table 5.3, the cost data have been converted into terms of 1977 prices using the price indices for the U.K. given in OECD (1980). This shows that, in real terms, the authorities' costs of waste collection and disposal have increased by 163 per cent over this period, 1963-64 to 1979-80. This represents an annual increase of 6.2 per cent. The percentage increase in disposal costs (9 per cent per annum) has been greater than that for collection costs (5 per cent per annum).

Table 5.2 The costs of municipal waste collection and disposal in the U.K. 1963/64 to 1979/80(2)

£m. (current prices)

YEAR	Collection Costs £m.	Collection Costs (% Change p.a.)(1)	Disposal Costs £m.	Disposal Costs (% Change p.a.)(1)	Total Costs £m.	Total Costs (% Change p.a.)(1)	% Change 1963-64 to 1979-80	Source
1963-64	n.a.		n.a.	-	50.9	-		Metal Box (1975)
1967-68	n.a.		n.a.		75.5	(+10.4%)		Metal Box (1975)
1972-73	109.0	-	34.0	-	143.0	(+13.6%)		Metal Box (1975)
1974-75	n.a.		55.5	(+27.8%)	n.a.			SCT (1976a)
1975-76	194.0	(+21.2%)	76.6	(+38.0%)	270.6	(+23.7%)	+979%	INCPEN (1976), SCT (1976b)
1976-77	251.7	(+29.7%)	89.9	(+17.4%)	341.6	(+26.2%)		CIPFA (1977), SCT (1978a)
1977-78	287.8	(+14.3%)	105.4	(+17.2%)	393.2	(+15.2%)		CIPFA (1978)
1978-79	317.9	(+10.5%)	120.8	(+14.6%)	438.7	(+11.6%)		CIPFA (1979), SCT (1978b)
1979-80	390.9	(+23.0%)	158.3	(+31.0%)	549.2.	(+25.2%)		CIPFA (1980a, 1980b)

Sources: Society of County Treasurers (SCT) (1976a, 1976b, 1978a, 1978b)
Chartered Institute of Public Finance and Accountancy (CIPFA) (1977, 1978, 1979, 1980a, 1980b)
INCPEN (1976)
Metal Box (1975)

(1) See note (1) Table 5.1

(2) The local authorities' income (from the sale of recycled materials and from waste collection and disposal charges) have been deducted to arrive at the 'net' cost figures given above for 1974-75 to 1979-80. It is not certain whether the Metal Box data used for 1963-64 to 1972-73 relate to 'Gross' or 'Net' costs.

(3) See note (3) Table 5.1.

Table 5.3

The real costs of municipal waste collection and disposal in the U.K. 1963-64 to 1979-80[2] with forecasts for 1982-83. (£m. constant 1977 prices)

	Collection Costs		Disposal Costs		Total Costs		
YEAR	£m.	(% Change p.a.)[1]	£m.	(% Change p.a.)[1]	£m.	(% Change p.a.)[1].	(% Change 1963-64 to 1979-80)
1963-64	n.a.		n.a.		169.2	(-)	
1967-68	n.a.		n.a.		217.1	(+6.4%)	
1972-73	228.4	-	71.2		299.6	(+6.7%)	
1974-75	n.a.		92.6	(+14.0%)	n.a.		
1975-76	260.5	(+4.5%)	102.9	(+11.1%)	363.4	+6.7%	+163%
1976-77	291.9	(+12.1%)	104.2	(+1.4%)	396.2	(+9.0%)	
1977-78	287.8	(-1.4%)	105.4	(+1.2%)	393.2	(-0.8%)	
1978-79	291.6	(+1.3%)	110.8	(+5.1%)	402.4	(+2.3%)	
1979-80	316.4	(+8.5%)	128.2	(+15.7%)	444.6	(10.5%)	
1982-83	366.3[E]	(+5.0%)	185.0[E]	(+13.0%)	551.3[E]	(+7.4%)	

Sources: As in Table 5.2
OECD (1980)

(1) See note (1) Table 5.1
(2) See note (2) Table 5.2
(3) See note (3) table 5.1
E = Forecasts

5.2.3(iv) Forecasts for waste collection and disposal costs

This trend of increases in the costs of waste management is expected to continue in the future and the rate of increase in the (real) costs of waste disposal may even accelerate in the 1980s on account of the problems of finding suitable landfill sites. Thus, Nottinghamshire County Council forecast that the costs of waste disposal in landfill sites - traditionally the cheapest waste disposal technique - would increase by 159 per cent (in real terms) between 1977 and 1980. Therefore, the forecasts for the local authorities' costs of waste collection and disposal, shown in Table 5.3, have been based upon an annual increase in the real costs of waste collection and disposal of 5 per cent and 13 per cent, respectively. This means that the authorities' costs of waste collection and disposal are estimated to be £366m. and £185m., respectively, in 1982-83 (1977 prices). Dividing these totals by the projections for the weight of municipal waste in 1982-83, this yields an estimated average cost of waste collection and disposal in 1982-83 of about £20 per tonne and £10 per tonne, respectively (1977 prices).

The data presented in Tables 5.1-5.3 are subject to a certain degree of error and uncertainty. In particular, the data are subject to the four limiting factors that were analysed earlier with respect to the SCT and CIPFA estimates for 1976-77 and 1977-78. If the same adjustments that were made earlier for these four factors are applied to the forecasts, then the estimated average costs of domestic waste collection and disposal for 1982-83 become approximately £24 per tonne and £10 per tonne, respectively (1977 prices).

5.3.4 The marginal costs of waste management

It is very difficult to derive an estimate, especially on a national scale, of the marginal costs of solid waste management. For this aspect, the appropriate concept is the long run marginal costs of waste management which incorporate the (discounted) value of changes in the level of waste management costs in future time periods arising from variations in the volume of waste generated.

Nevertheless, a review of the literature and the opinions of various authorities has revealed some information on this important matter.

Lidgren (1976), Blackmore and Turner (1978) and INCPEN (1981) have suggested that the marginal costs of waste collection are virtually zero, on account of the highly fixed nature of the collection schedules. Thus, waste collection costs which are unlikely to be altered, in the short run, by a small change in the volume of municipal waste generated. However, Gosling (1973) notes that increases in the volume of waste generated have led to an increase in the number of dustbins used by householders - and hence an increase in the time required to collect the waste from households - and have also resulted in the need for more expensive collection vehicles fitted with refuse compaction equipment (see also Staudinger [1970), Tanner (1974)]. Therefore, a significant change in the volume of municipal waste generated might lead to some long run impacts upon waste collection costs.

The changes in disposal costs resulting from a change in the volume of waste generated will, in the short run at least, be limited by the fixed nature of many components of waste disposal costs, especially for the highly capital intensive disposal techniques such as incineration. Nevertheless, changes in the volume of solid waste generated could result in some reduction in maintenance costs and will extend the life of landfill sites. This latter aspect could yield significant long-term benefits in those areas where there is a shortage of available landfill sites. Some sources have suggested that mineral extraction creates sufficient sites for the disposal of wastes [e.g., see DOE (1971), LGORU (1975), Wilcox (1976)]. Therefore, reductions in the volume of waste generated would yield fairly small savings in the future waste management costs of those waste disposal authorities for whom such waste disposal sites are readily available.

Nevertheless, many other waste disposal authorities, especially for the larger metropolitan areas, face severe problems over finding 'suitable' landfill sites [LGORU (1972a, 1974), Gosling (1973), Bratley (1977), Wilson (1978), Brunskill (1978)]. The reasons given for this shortage are that many of the available sites are unsuitable for the disposal of waste on account of a lack of adequate cover material and poor access for the refuse vehicles. In addition, there is increasing public opposition to proposed landfill sites as a result of concern by local residents over their adverse environmental impacts and many sites fail to satisfy the strict conditions that the water authorities stipulate to reduce the risk of leachate from the landfill site contaminating ground and surface water [e.g., see Severn Trent Water Authority (1976)].

Furthermore, most refuse is generated in areas of high population density that are not necessarily close to the mineral extraction sites. The best landfill sites for disposing of the waste from these areas have already been used. Many of the remaining available sites are further away entailing greater transport distances. Increased expenditure would also be required to improve the disposal operations at these sites so that they can be performed in accordance with the standards recommended by the Sumner report, which also states that landfill - the cheapest method of waste disposal (in financial terms) - should not be used if these standards cannot be met [DOE (1971)]. Thus, the costs of waste disposal by landfill are expected to rise considerably in the future.

Moreover, the use of more remote landfill sites could result in increased refuse collection costs since it would increase the unproductive time that the collection vehicles spend travelling to the site to dispose of their load and this will cause more local authorities to spend money on transfer stations [LGORU (1975)]. The lack of available landfill sites is also forcing some WDAs to adopt more expensive waste treatment techniques, such as pulverisation or incineration, in order to reduce the volume of waste to be disposed [LGORU (1972a)]. In the light of these factors, reductions in the volume of waste generated would yield significant long term savings in waste management costs for those waste disposal authorities suffering from a shortage of suitable landfill sites.

Very little quantitative data are currently available on the marginal costs of waste disposal. Blackmore and Turner (1978) estimated that the value of savings in landfill site space was about 10p. per m^3 or 25p. per tonne, in 1978. Nottinghamshire County Council said that the value of savings in landfill space was about 25p. per m^3 or 63p. per tonne. The LGORU [LGORU (1975)] estimates the effect of a 10 and 20 per cent reduction in waste levels upon the treatment costs (not total disposal costs) for the following waste treatment techniques: incineration £0.34-£1.23 per tonne of waste reduced; pulverisation £0.27-£0.35 per tonne; baling £0.18-£0.27 per tonne. Lidgren (1976) assumes that the marginal costs of waste disposal are half the average costs of waste disposal. However, Pearce (1976) and Turner (1978) consider that the marginal costs of waste disposal are represented by the current average costs of waste disposal.

To sum up: it is difficult to derive a precise, quantitative estimate of the long run marginal costs of waste management, especially at a national level which requires a balanced aggregation of the diverse particular local situations. The available information presented above indicates that the marginal costs of waste collection are low on account of the highly fixed nature of waste collection costs. Fixed costs also constitute a large component of waste disposal costs so that a reduction in waste levels would just have a limited effect on waste management costs in the short run. However, a reduction in the volume of waste generated would yield substantial long run savings for the many (metropolitan) waste disposal authorities that will encounter significant problems in finding suitable landfill sites in the near future. Consequently, it is considered that the marginal costs of waste disposal are approximately equal to the average costs of waste disposal.

For the analysis in this thesis, the marginal costs of waste management are taken to be approximately equal to the average costs of waste disposal(6). Thus the marginal costs of domestic waste management would be about £6.00 per tonne in 1977-78 and are estimated to be about £10 per tonne, in 1982-83 (1977 prices).

5.4 The size of the beverage container component of domestic waste

Up until now, little data were available on the size of the beverage container component of the waste stream. Porteous (1978b) and Shelley (1978) had made some 'guesstimates' for this on the basis of certain assumptions about the contribution of beverage containers to the total glass and metal wastes, which were two of the seven categories analysed in the DOE's annual refuse composition analyses.

Therefore, in order to determine more accurately the size of the beverage container component of domestic waste, the DOE agreed to ask county councils to separate out and

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(6) This is the same as the measure adopted in INCPEN (1981)

weigh the beer, cider and carbonated soft drinks bottles and cans from the glass and metal fractions in the refuse composition analyses for 1978. Accordingly, a set of instructions for the identification and separation of the beverage containers was drawn up. This was then sent to experts in the beverage and glass industries to check whether the distinguishing features of the various containers had been correctly specified, and a pilot separation exercise was undertaken to test the feasibility of following the instructions. As a result of the experience gained, the instructions were revised. Appendix III shows the final instructions sheet that was circulated to all county councils by the DOE. Enquiries were made with all county councils, who had expressed an interest in undertaking the general refuse composition analysis during 1978, to determine whether they would also be undertaking the separation of the beverage containers and, if so, to check that the instructions could be followed and to clear up any possible problems that they might envisage arising. These enquiries revealed that the samples of waste are specially collected in a non-compacted state so that there was little breakage of bottles which could be fairly easily separated. The waste disposal officers concerned reported that they did not foresee any difficulties in following the instructions(7).

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(7) In fact, the enquiries also revealed that some local authorities had already undertaken the separation of the beverage containers without encountering any difficulties in identifying and separating the various types of containers for carbonated beverages.

It is acknowledged that the quantity and composition of domestic waste generated can vary significantly between different times of the year and between different parts of the country. However, the DOE had selected October as the date for the annual composition analyses since this is considered to be a fairly 'typical' month being neither winter nor summer. In relation to the second aspect, it was most fortunate that so many county councils co-operated in the beverage container analysis. The separation of the beverage container component of solid waste was undertaken in 1978 by 21 local authorities in various parts of the country ranging from Cornwall in the south-west of England to Dundee in the East of Scotland[8]. In addition, further analyses were undertaken by West Yorkshire County Council in 1979, and by Merseyside County Council in 1980. In total, 131 analyses were undertaken of the beverage container component of nearly 100 tonnes of waste from more than 9,100 households. The results of the survey are summarised in Table 5.4, which shows that beer, cider and carbonated soft drinks containers constitute about 3 per cent of total domestic waste[9].

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(8) Appendix III lists those Councils that performed these composition analyses.

(9) A more detailed breakdown of the glass and metal fraction was undertaken in 3 of the analyses. This revealed that the containers for all beverages (including wines, spirits, cordials, fruit juices and dairy products, as well as carbonated beverages), constituted about 7 per cent of the total weight of domestic waste in these analyses.

Table 5.4

Summary of the results of the analyses of the carbonated beverage container component of domestic waste

Number of households from which waste was analysed		9,178
Total weight of waste analysed (Kgs.)		98,108
Weight of beer, cider and carbonated soft drinks containers in waste (Kgs.)		
- Returnable Bottes	325.5	
- Non-returnable bottles	1,873.2	
- Cans	714.8	
Weight of carbonated beverage containers (Kgs.)		2,913.5
'Carbonated' beverage containers as % of total waste analysed		2.97%

Source: DOE's Waste Composition Analyses undertaken in October 1978, 1979 and 1980.
Merseyside County Council (1981)

Table 5.5

The size of the carbonated beverage container component of solid waste - materials balance approach -

		Weight tonnes p.a.
Annual weight of 'carbonated' beverage containers in waste (tonnes p.a.)		
- Returnable bottles	153,289	
- Non-returnable bottles	258,735	
- Cans	107,422	
Total carbonated beverage containers in waste (tonnes)		519,446
Estimate of total domestic waste (tonnes)		14,000,000
'Carbonated' beverage containers as % of total domestic waste		3.7 per cent

Source: Metal Box Market Research Division

In addition, a materials balance analysis was performed. This was based upon estimates of the 'off' premise sales of beer, cider and carbonated soft drinks in 1977 in the various types of containers and the unit weights of these containers. The detailed calculations are given in Appendix IV and a summary is presented in Table 5.5, which shows that an estimated 519,500 tonnes of carbonated beverage containers are disposed annually in domestic waste. This represents 3.7 per cent of the total domestic waste.

However, the materials balance approach is subject to four limitations. First, as was noted earlier in section 5.3.1, there is some uncertainty concerning the appropriate figure for the divisor - the total quantity of domestic waste generated annually in the U.K. In deriving the figure shown in Table 5.5, a downward adjustment of 14 per cent has been made to the SCT estimates [SCT (1977)] to allow for the apparent tendency of local authorities to overestimate the weight of waste they manage.

Second, systematic statistics are not kept on 'off' premise beverage sales. The data presented in Appendices II and IV are based upon some assumptions concerning the various sectors of the beverage market and represent best available informed 'guesstimates' rather than perfectly precise figures (see Appendix II).

Third, little information is available on the 'off' premise trippage of returnable beverage containers. An estimate for trippage is required to convert the unit 'off' premise sales of beverages in returnable bottles into terms of the number of bottles that are not returned and, hence, end up in solid waste. The calculations in Appendix IV and Table 5.5 were based upon an assumed 'off' premise trippage of four, which was the figure adopted in the WMAC report [WMAC (1980)]. Chapter 10 reports the results of surveys of a limited number of retailers which gives slightly higher estimates for the 'off' premise trippage of returnable cider bottles ($\doteq 7$) and carbonated soft drinks bottles ($\doteq 5$). If these higher trippage figures are used, then the carbonated beverage container component of domestic waste becomes about 3.5 per cent.

Finally, the materials balance approach is based on the principle that:-

Inputs (production) $\pm$ accumulation = output (waste)

Accordingly, the sales figures give a good estimate for the quantities of beverage containers in waste provided there is no accumulation of beverage containers at the households or no leakage of beverage containers into long-term litter. However, some of the bottles that are not returned, may not end up in solid waste but may be kept by the householders for other purposes (e.g., home brewing). Thus, chapter 10 reports the results of a consumer survey which showed that about 6 per cent of householders said that they did not return a bottle because they retained it for such other uses. Therefore, in the light of this factor, the earlier figure from the materials balance analysis should be lowered slightly.

Thus, it is apparent that both the material balance and waste composition analyses could be subject to certain limitations. However, the similarity between the figures from these two separate measurement methods suggest that these limitations have been successfully overcome and indicate that carbonated beverage containers constitute between 3-3.5 per cent of the total weight of domestic waste.

The data from Tables 5.4 and 5.5 have been converted into terms of the more relevant volume measure in Table 5.6, using some (tentative) estimates for the densities of domestic waste that were derived from the waste composition analyses. These densities relate to waste that has received very little compaction, i.e., this is similar to the waste in the householder's dustbin prior to its collection. The density of such relatively uncompacted waste has been used in this analysis because, apart from there being more measured data available on this form of waste, it is increases in the volume of such relatively uncompacted waste that causes local authorities to use more expensive collection vehicles with waste compaction devices and to treat the wastes generated by households so as to reduce the volume of waste to be disposed.

Thus, 'carbonated' beverage containers would appear to constitute about 3.0-3.5 per cent of the total weight of domestic waste and about 2 per cent of the volume of domestic waste.

5.5 Solid waste ranking of the alternative carbonated beverage containers

Table 5.7 gives a sub-division of the carbonated beverage container component from the DOE waste analyses

Table 5.6 The size of the beverage container component of the volume of domestic waste

Waste Category	Densities	DOE Waste Composition Analyses		Materials Balance Approach	
				Weight	Volume
	(Kg/m^3)	Wgt (Kgs.)	Vol.(m^3)	'000's tonnes p.a.	'000's m^3 p.a.
Beverage Containers					
Bottles	371	2,198.7	5.93	412.0	1,110.6
Cans - BM	116	714.8	6.16	100.3	864.8
- AL	53	n.a.	n.a.	7.1	134.0
Total beverage containers		2,913.5	12.09	519.5	2,109.4
Total domestic Waste	138.5	98,108.0	708.4	14,000	101,083.0
Carbonated beverage containers as % of total domestic waste		2.97%	1.7%	3.7%	2.1%

Source: DOE Waste composition analyses
Merseyside County Council (1977)
Metal Box Market Research Division
Information supplied by the Greater London Council.

(1) BM = Bimetallic can (tinplate can with aluminium top)
AL = All aluminium can

(2) No data were available on the density in domestic waste of the lighter all aluminium cans. A density of 53 kg/m^3 has been assigned to the aluminium cans in this analysis. This is half of the density figure given in the waste composition analyses for all metal cans.

into returnable bottles, non-returnable bottles and cans. These quantities have then been compared with estimates for the 'off' premise sales of beer, cider and carbonated soft drinks in each container to yield a solid waste ranking of these containers. This ranking indicates whether more or less solid waste is generated by the sale of the same volume of beverage in returnable or non-returnable containers. Table 5.8 gives the ranking of the containers in terms of the more relevant volume measure of solid waste. This shows that the volume of solid waste generated by the use of non-returnable bottles is about 13 times greater than the volume of solid waste generated under the returnable system and that the use of non-returnable cans generates about six times as much volume of solid waste as the returnable system.

However, the ranking of the returnable bottle depends essentially upon the trippage achieved by this bottle. Therefore, data from the materials balance analysis have been used to estimate the break-even trippage that the returnable bottle must achieve in order to generate less solid waste than the non-returnable containers. Table 5.9 gives the volume and weight of domestic waste arising from the distribution of 1,000 litres of beer in 10 oz. non-returnable bottles and cans and 10 oz. returnable bottles with trippages of one, five, ten and twenty. Table 5.9 indicates that the returnable bottle has to achieve a trippage of 1.5 to generate less domestic waste than the non-returnable bottle. The returnable bottle has to attain a trippage of about 2 to generate a lower volume of domestic

Table 5.7

Solid waste ranking of the alternative beverage containers - weight

Beverage Container	Carbonated Beverage Containers in DOE Waste Analyses Weight (kgs.) (A)	'Off' Premise beer, cider and carbonated soft drinks sales Volume in each container 1977 - (10^6 litres) (B)	Solid Waste Ranking	
			(A)÷(B)	Index
Returnable Bottle.	325.5	800	0.41	(1)
Non-returnable Bottle	1873.2	348	5.38	(13.1)
Metal Can	714.8	935	0.76	(1.9)

Source: DOE Waste composition analyses, Merseyside County Council (1981), Metal Box Market Research Division

Table 5.8

Solid waste ranking of the alternative beverage containers - volume

Beverage Container	Beverage Containers in DOE Waste Analyses Volume (m^3) (A)	'Off' Premise beer, cider, and carbonated soft drinks sales Volume in each container 1977 - (10^6 litres) (B)	Solid Waste Ranking (A)÷(B) (x1000)	Index
Returnable Bottle	0.88	800	1.1	(1)
Non-returnable Bottle	5.05	348	14.5	(13.2)
Metal Can	6.16	935	6.6	(6.0)

Source: DOE Waste composition analyses, Merseyside County Council (1981), Metal Box Market Research Division waste than the bimetallic and aluminium cans and, in order to generate a lower weight of domestic waste than the bimetallic and aluminium cans, the returnable bottle has to achieve a trippage of about 7 and 17, respectively. Table 5.10 gives data for soft drinks. Soft drinks bottles are heavier than beer bottles on account of the greater internal pressure of soft drinks carbonation, and this results in the break-even trippages for the returnable soft drinks bottles being slightly higher than those for beer.

The data in Tables 5.7-5.10 relate only to the weight and volume of the actual containers and do not include the supplementary packaging required for the distribution of these containers to the consumer. The domestic waste generated by the containers' supplementary packaging will be highest for the non-returnable bottles which are normally packed in paperboard cartons, and lowest for the returnable bottles, which are distributed in plastic crates that achieve a high trippage. Therefore, the inclusion in the analysis of the supplementary packaging for the alternative beverage containers should not alter the solid waste ranking given earlier for the alternative containers. However, it will mean that the break-even trippages for the returnable bottles will be slightly lower than those shown in Tables 5.9 and 5.10.

5.6 The external costs of carbonated beverage containers in domestic waste

Chapter 4 raised the question of whether the external costs of beverage containers are represented by the average or the marginal costs of controlling an externality.

Table 5.9

Break-even trippage for the returnable bottle to generate less domestic waste than the non-returnable bottle and can - BEER

Beverage Container	Solid Waste generated by the distribution of 1000 litres of beer in each container		Break-even trippages for the returnable bottle in cfn with the non-returnable bottles and cans	
	Wgt (Kgs)	Volume (m^3)	Weight	Volume
10 oz. NRB	704	1.9	1.5	1.5
10 oz. Can-Bimetallic	148	1.3	7.1	2.2
-Aluminium	≏ 63	≏ 1.2	≏ 16.8	≏ 2.4
10 oz. RB T = 1	1,056	2.85	-	-
T = 5	211	0.57	-	-
T = 10	106	0.28	-	-
T = 20	53	0.14	-	-

Source: Metal Box Market Research Division

RB = Returnable glass bottle
NRB = Non-returnable glass bottle
T = Trippage of the returnable bottle (the number of times a returnable bottle is used for the distribution of beverages)

Table 5.10

Break-even trippages for the returnable bottle to generate less domestic waste than the non-returnable bottle and can - SOFT DRINKS

Beverage Container	Solid Waste generated by the distribution of 1000 litres of soft drinks in each container		Break-even trippages for the returnable bottle in cfn with the non-returnable bottles and cans	
	Wgt (Kgs)	Volume (m^3)	Weight	Volume
10 oz. NRB	739	1.99	1.7	1.7
12 oz. Can-Bimetallic	148	1.3	8.5	2.6
-Aluminium	$\simeq$ 63	$\simeq$ 1.2	$\simeq$ 19.8	$\simeq$ 2.8
10 oz. RB T = 1	1,250	3.37	-	-
T = 5	250	0.67	-	-
T = 10	125	0.34	-	-
T = 20	62	0.17	-	-

Source: Metal Box Market Research Division

RB = Returnable glass bottle
NRB = Non-returnable glass bottle
T = Trippage of the returnable bottle (the number of times a returnable bottle is used for the distribution of beverages)

This question is particularly relevant and important to this specific aspect of the current beverage container debate, since there is a significant difference between the average and the marginal costs of waste management. Therefore, the arguments concerning the selection of the appropriate measure for external costs are examined further here.

The integral activity of waste management does entail abatement costs (waste collection and disposal costs) which, as was shown in section 5.1, do constitute external costs since these abatement costs are not included in the price of the goods that are disposed of.

In many countries, there is concern over the increasing levels of these (external) costs of managing the rising quantities of wastes being generated. Thus Menke-Glukert, Ministerial Director of the Bundesministerium des Innern in West Germany [Menke-Glukert (1980, p.1.)] states that:

> "Waste quantities will increase in the forthcoming decade.... The waste problem will continue to gain importance. ....The direct waste prevention (prevention at source) has to be more emphasized in the future than it is to date."

This concern has caused the governments in these countries to implement an overall solid waste management policy to reduce at source the level of solid waste generated. In many cases, this general policy has included measures to reduce specific components of the waste stream, in particular beverage containers. Thus Appendix I shows that the beverage container policy of the Federal Republic of Germany is embodied in the government's overall waste management policy and that the overriding objective of this beverage container policy is to prevent any increase in the amount of beverage containers in domestic solid waste.

Furthermore, in the context of the debate in the U.K. concerning beverage containers, Cawdell (1980) argues that one cannot afford to overlook the need to take measures concerning specific identifiable components of the overall waste stream, even though each of these specific components may appear small when taken on their own. Thus he states [Cawdell (1980, p.5)] that:

> "Almost any problem can be made to look insignificant by viewing it from a broad enough perspective. In practice, though, it is only by tackling small manageable issues one by one that wider problems........ can be handled."

Therefore, in the light of these factors and in accordance with externality correction theory and the polluter-pays principle, these external costs of waste collection and disposal should be allocated to all the goods that end up in domestic waste - or perhaps just to the major contributors to and components of the domestic waste stream. Thus, the US Environmental Protection Agency [US EPA (1977)] proposed that a product charge should be levied on packaging, which constitutes about 30-60 per cent of total municipal waste [OECD (1978)]. Beverage containers are one component of packaging and were included within the scope of this product charge. The level of this proposed charge was based upon the average costs of waste collection and disposal.

However, the reductions in waste levels following the implementation of such policies would yield financial savings in waste management costs which would equal, not the average, but the marginal costs of waste collection and disposal. Furthermore, the waste disposal and collection costs attributable to a particular individual good are represented by the marginal costs of waste management. Therefore, in relation to these considerations, marginal costs could also be the appropriate measure.

This question has not yet been resolved in the current literature. Its resolution would depend upon the factors highlighted above, in particular whether the action concerning a particular product is part of a general policy to reduce the overall level of solid waste generated. On account of this uncertainty about the appropriate measure, the following empirical analysis estimates the external costs of beverage containers on the basis of both the average and the marginal costs of waste management.

Table 5.11 presents estimates of the external costs of waste management that have been derived using these two alternative measures. Table 5.11 also gives the cost per tonne figures in terms of their equivalent costs per m^3 of waste. Officials at the Department of Environment suggested that an average of the results obtained from using the cost per tonne and cost per m^3 figures should be adopted in calculating the external costs arising from the beverage containers in domestic waste. Accordingly, this procedure was followed and the resulting estimates are presented in Table 5.12. This shows that the generation of 519,500 tonnes of waste beverage containers in 1977-78 creates external waste management costs of about £10.19m when the average costs measure is adopted, and about £2.43m when marginal costs are used.

Table 5.11

The external costs of solid waste management

£s (1977 prices)

YEAR	Measure of external cost of waste management			
	Average costs		Marginal costs	
	per tonne	per m^3	per tonne	per m^3
1977-78	25.0	3.5	6.0	0.83
1982-83	34	4.43	10.0	1.3

Source: Data presented in section 5.3.

Table 5.12

The annual external costs of the beverage containers in domestic solid waste (£s p.a. 1977 prices)

YEAR	Beverage container waste		External costs of waste beverage containers(1)	
			Alternative measures	
	000s tonnes per annum	000s m^3 per annum	Average costs	Marginal costs
1977-78	519.5	2109.4	10.19m (13.0m-7.4m)	2.43m (3.1m-1.8m)
1982-83 ('No action') scenario II)	693.9	2910	18.3m (23.6m-12.9m)	5.4m (6.9m-3.8m)

(1) The figures in the brackets refer to the range given by the use of the weight and the volme figures. The higher figure in each bracket relates to the use of weight.

Table 5.12 also shows that the quantities of beverage container waste generated annually are forecast to rise by 34-38 per cent over the period 1977 to 1982 so that, under the 'No action' scenario II for 1982, beverage container waste is expected to amount to a maximum of about 693,900 tonnes per annum, which is equivalent to about 2.9 million cubic metres[10]. This rise is due to the growth in sales of packaged beverages, especially in non-returnables. The predicted increases (in real terms) in the costs of waste management mean that the costs of collecting and disposing of these waste quantities will be higher (by 80-122 per cent) so that, in 1982, it is forecast that these costs will amount to about £18.3m under the average cost measure, and about £5.4m under the marginal cost measure.

The same procedure has been followed to calculate the unit external waste management costs for an individual container. Table 5.13 gives the resulting estimates for the main popular sizes of beverage containers. This shows that, if the average cost measure is adopted, the unit external waste management costs arising in 1977-78 from the disposal of a 20 oz. returnable bottle, a 20 oz. non-returnable bottle, a 16 oz. bimetallic can and a 16 oz. aluminium can are about 0.8p, 0.6p 0.15p and 0.1p, respectively. If the

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(10) It was noted in Appendix II that it was not possible to obtain data on the likely weights of the containers in 1982. Therefore the container weights of 1977 had to be used in the analysis for 1982. This procedure overstates the increase in the weight of waste beverage containers to the extent of any improved lighter containers being developed. Therefore, these figures given above (and throughout the next section) represent maximum estimates.

Table 5.13 The unit external waste management costs arising from the disposal of the principal beverage containers in 1977. (1977 prices)

Beverage container		Unit external waste management costs(1)					
Type	Size	Average cost measure pence per container			Marginal cost measure pence per container		
		T=1	(T=5)(2A)	[T=10](2B)	T=1	(T=5)(2A)	[T=10](2B)
Returnable Bottle	10 oz.(1)	0.57	(0.12)	[0.06]	0.13	(0.03)	[0.01]
	20 oz.(1)	0.81	(0.16)	[0.08]	0.19	(0.04)	[0.02]
	40 oz(1)	1.25	(0.24)	[0.13]	0.3	(0.06)	[0.03]
Non-returnable Bottle	10 oz.(1)	0.35			0.09		
	20 oz.(1)	0.63			0.15		
	litre(1)	1.06			0.25		
Cans BM	12 oz.	0.12			0.03		
AL	10 oz.	0.08			0.02		
BM	16 oz.	0.15			0.04		
AL	16 oz.	0.1			0.03		
BM	5 pint	0.86			0.2		

Source: Tables 5.6, 5.11 and Appendix IV.

(1) The container weights used are those given in Appendix IV. For the 10 oz., 40 oz. and litre bottles, the average of the weights of these sizes of soft drinks and beer bottles has been used. The 20 oz. bottle is a pint beer bottle since soft drinks are not sold in this size of bottle.

(2) The figures in brackets allow for the effects of the trippage (T) of a returnable bottle in reducing the external costs arising from the final disposal of the bottle.
(3A) These figures ( ) relate to a trippage of 5.
(3B) These figures [ ] relate to a trippage of 10.

(4) BM = Bimetallic can
AL = All aluminium can

marginal cost measure is used, then the external waste management costs of a 20 oz. returnable bottle, a 20 oz. non-returnable bottle, a 16 oz. bimetallic can and a 16 oz. aluminium can are about 0.19p, 0.15p, 0.04p, and 0.03p respectively. The waste management costs for returnables are reduced proportionately by their re-use. Thus, if the returnable bottle is used ten times (a trippage of 10), then the external waste management costs of the returnables become 0.08p per bottle (under the average cost measure) and 0.02p (under the marginal cost measure).

If a product charge was levied on beverage containers to cover the waste management costs arising from their disposal, then, in 1977, this product charge should be set under the average cost measure at 0.8p per new returnable bottle produced(11), 0.6p per non-returnable bottle, 0.15p per bimetallic can and 0.1p per aluminium beverage can. Under the marginal cost measure, this charge should be 0.19p per new returnable bottle produced(11), 0.15p per non-returnable bottle, 0.04p per bimetallic can and 0.03p per aluminium can. On account of the predicted increases in the real costs of waste management, and particularly waste disposal, a product charge calculated on the basis of average costs would have to rise by 34 per cent (in real terms) between 1977 and 1982,

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(11) This product charge would only be levied on new bottles produced and not on old bottles returned and re-used by the bottlers. Therefore, this charge would be amortized by the trippage of the bottle. Thus, if the trippage was 10, then the average cost based charge would amount to 0.08p per <u>filling</u> of beverages in returnables and the marginal cost based charge would be about 0.02p per filling.

and a product charge based on marginal costs would have to rise by about 64 per cent (in real terms) by 1982. In 1982, such a product charge on a 20 oz. non-returnable bottle would, under the average cost measure, be about 0.84p per bottle and, under the marginal cost measure, would be about 0.25p per non-returnable bottle (1977 prices).

5.7 The quantities of carbonated beverage containers in domestic waste and their external waste management costs under the different scenarios for 1982.

Table 5.14 shows the changes in quantities of carbonated beverage containers in domestic waste and changes in the waste management costs arising under the different scenarios II-IX for 1982. Table 5.15 presents a summary description of the principal features of these scenarios. A comparison of these features of the different scenarios and their resulting impacts yields some interesting implications.

Scenario III is an extrapolation of the current trends in the U.K. beverage market, of a greater use of non-returnables, to the situation where there is a complete demise of returnable bottles. Table 5.14 shows that under this completely non-returnables scenario III, the annual generation of waste beverage containers would increase to a maximum of about 948,500 tonnes per annum which is about 3.7 million cubic metres of waste. This would represent about 4 and 7 per cent, respectively, of the total volume and weight of domestic waste. Under the marginal cost measure, the external waste management costs of beverage containers in this scenario III would increase by 33 per cent to about £7.1m.

Table 5.14 shows that if, as in scenario IV, the returnable bottle was able in 1982 to maintain the market share and trippage achieved in 1977, then the annual generation of waste beverage containers would be about 11 per cent lower than the quantity generated under the 'No action' scenario II. This reduction would mean an annual saving in waste management costs of about £574,400 per annum (in comparison with the baseline scenario II).

Scenario V shows that, if the current trends of a deteriorating position for returnables are actually reversed, then the quantities of waste beverage containers could be decreased by 175,000 tonnes per annum, or 872,000 cubic metres per annum. This would yield annual savings in waste management costs of about £1.44m (in 1977 prices). This saving represents about 0.3 per cent of the total costs of domestic waste collection and disposal in the U.K. in 1982. This reduction in the amount of waste beverage containers is due to the substitution of non-returnable bottles by returnable bottles and the higher trippage for the returnable bottles in this scenario.

The importance of the trippage of a returnable bottle can be seen by comparing the results for scenarios V and VI. Under scenario VI, the returnable's trippage does not increase but remains at the 'No action' Scenario II level of 3. Table 5.15 shows that, under this scenario VI, the external costs of managing the waste beverage containers decrease by only 1 per cent whereas, under the higher trippage scenario V, the external waste management costs of

Table 5.14 The changes in the quantities of beverage container waste and in waste management costs under the different scenarios for 1982 £'000s p.a. (1977 prices)

Scenario for 1982	Beverage container waste generated: Weight '000s tonnes p.a.	Weight vs Scenario II '000s tonnes p.a.	Weight vs Scenario II %	Volume '000s m^3 p.a.	Volume vs Scenario II '000s m^3 p.a.	Volume vs Scenario II %	External Waste Management Costs (Marginal cost measure) £'000s p.a.	savings(-)/increase(+) in cfn with scenario II £'000s p.a.	savings(-)/increase(+) in cfn with scenario II %
II - No Action	693.9	-	-	2910	-	-	5361.0	-	-
III - 100% NRF	948.5	+255	+37%	3683	+773	+27%	7136.5	+1775.5	+33%
IV - 1977 Market shares, T=4	620.5	- 73	-11%	2591	-319	-11%	4786.7	- 574.4	-11%
V - RB↑ T = 6	519.4	-175	-25%	2038	-872	-30%	3921.7	-1439	-27%
VII - RB↑ T = 3	725.0	+ 31	+ 5%	2592	-318	-11%	5309.8	- 51.2	- 1%
VII - Mandatory deposits	233.1	-460.9	-66%	1344	-1566	-54%	2039.1	-3321.9	-62%
VIII - 100% RB, T=10	233.2	-461	-66%	629	-2281	-78%	1574.9	-3786.2	-71%
IX - 100% RB, T=15	155.5	-538	-78%	419	-2491	-86%	1050.0	-4311.2	-80%

Note: NRF = Non-returnable bottles and cans
RB = Returnable bottle
T = Trippage of the returnable bottle
Δ = Change in
The above estimates for the quantities and costs of beverage container waste do not allow for any reduction in the unit weight of non-returnable and returnable beverage containers that might arise for any of the scenarios for 1982. This means that these estimates might overstate, by an uncertain amount, the changes in waste quantities and costs. Consequently, the above figures represent maximum values for these changes.

Table 5.15 Principal features of the scenarios analysed

	SCENARIO	'OFF' Premise sales of beer, cider and carbonated soft drinks in millions of litres and as a % of total packaged 'off' premise beverage sales: Non-returnable Glass bottle Vol.	Non-returnable Glass bottle (% of Σ)	Non-returnable Metal Cans Vol.	Non-returnable Metal Cans (% of Σ)	Returnable Bottle Vol.	Returnable Bottle (% of Σ)	'OFF' Premise Trippage
I.	CURRENT SITUATION (1977)	348	(17%)	935	(45%)	800	(38%)	4
II	'NO ACTION' Forecast for 1982	511	(20%)	1375	(52%)	730	(28%)	3
III	100% Non-returnable system	1129	(43%)	1487	(57%)	0	(0%)	not applicable
IV	Market shares and trippage achieved by the returnables in 1977 (1)	418	(16%) (1)	1214	(46%) (1)	984	(38%) (1)	4
V	Intermediate increase in Returnables' market share x2 trippage X 2	313	(12%)	843	(32%)	1460	(56%)	6
VI	Intermediate increase in Returnables' market share x2 - Lower Trippage	313	(12%)	843	(32%)	1460	(56%)	3
VII	FOE post-mandatory Deposit situation	0	(0%)	943	(36%)	1673	(64%)	10
VIII	100% Returnable system	0	(0%)	0	(0%)	2616	(100%)	10
IX	100% Returnable system - Higher trippage	0	(0%)	0	(0%)	2616	(100%)	15

(1) The market shares in 1977 between the different containers for each beverage (i.e., beer, cider and carbonated soft drinks) have been used in scenario IV for 1982. However, the aggregate market shares shown above for scenario IV are not exactly the same as the aggregate market shares in 1977 on account of differences in the sales growth rates between 1977 and 1982 for the different beverages.

beverage containers decrease by 27 per cent. The results for scenarios VII, VIII and IX further highlight the importance of trippage and the reductions in the quantities and external costs of waste beverage containers that could be obtained if the returnable's trippage and market share could be increased.

Table 5.14 shows that, in comparison with the 'No action' scenario II, the mandatory deposit policy scenario VII would reduce the weight and volume of waste beverage containers by 66 per cent and 54 per cent, respectively. Consequently, the external waste management costs of beverage containers would be 62 per cent lower under scenario VII than under the 'No action' scenario II. Thus, the implementation of mandatory deposits on containers for carbonated beverages in the U.K. would yield annual savings in waste management costs of about £3.32m in 1982 (1977 prices). This saving would represent about 0.7 per cent of the U.K. authorities' total costs of collecting and disposing of domestic waste in 1982.

5.8 Conclusion

The authorities' net costs of collecting and disposing of the domestic and commercial waste generated in the U.K. amounted to about £393m in the financial year 1977-78 (1977 prices). It is estimated that the average costs of collecting and disposing of domestic waste were about £19.0 per tonne and £6.00 per tonne, respectively, in 1977-78 (1977 prices). The costs of solid waste management have been increasing rapidly in recent years, along with the volume of solid waste generated, and it is predicted that these trends will continue in the future. Many waste disposal authorities face increasing problems over finding suitable landfill sites for the disposal of these rising quantities of waste. Thus, it is forecast that the average costs of domestic waste collection will increase, in real terms, to approximately £24 per tonne by 1982-83 and the increase will be greater for disposal costs, which are predicted to rise to about £10 per tonne in 1982-83 (1977 prices). Little quantitative data are currently available on the 'marginal' costs of solid waste management. The marginal costs of collecting waste are generally regarded to be low, while the marginal costs of waste disposal are considered to be roughly equal to the average costs of solid waste disposal. This indicates that the marginal costs of solid waste management would be about £6.00 per tonne, in 1977-78, and about £10 per tonne in 1982-83 (1977 prices).

131 analyses of the composition of domestic waste have been undertaken in various parts of the U.K., ranging from Cornwall to Dundee. These analyses, along with materials balance calculations, revealed that carbonated beverage containers constitute about 3-3.5 per cent of the total weight and about 2 per cent of the total volume of domestic waste. Examination of the relative quantities of the alternative beverage containers in the waste indicates that the use of non-returnable glass bottles generates the most domestic solid waste followed by the metal cans, with the returnable bottle generating the least domestic solid waste. However, this favourable ranking of the returnable bottle depends essentially upon the trippage achieved by this

bottle. It is estimated that the returnable bottle has to achieve a trippage of 1.5 to generate less domestic waste than the non-returnable glass bottle. The returnable bottle has to attain a trippage of between 2-3 to generate a lower volume of domestic waste than the bimetallic and aluminium cans. In order to generate a lower weight of domestic waste than the bimetallic and aluminium cans, the returnable bottle has to achieve a trippage of about 7-9 and 17-20, respectively.

The materials balance calculations reveal that about 519,500 tonnes of solid waste were generated by the containers used for 'off' premise sales of carbonated beverages in 1977. There is some uncertainty about whether the external costs of these waste beverage containers are represented by the average or the marginal costs of waste management. The arguments concerning this matter are reviewed in section 5.6 of this chapter. As yet, this question has not been successfully resolved and not even faced either in the current literature or in the political forum. On account of this uncertainty, the results for both measures are reported. Under the average cost measure, the external waste management costs for waste beverage containers were about £10.2m in 1977. Under the marginal cost measure, these external waste management costs were about £2.4m. Under the average cost measure, the unit external waste management costs for an individual 20 oz. returnable beer bottle, a 20 oz. non-returnable bottle, a 16 oz. bimetallic can and a 16 oz. aluminium can are about 0.8p, 0.6p, 0.15p and 0.1p per container, respectively. Under the marginal cost measure, the unit external waste management costs for these beverage containers are about 0.19p, 0.15p, 0.04p and 0.03p, respectively. These unit external waste management costs will increase by 34-64 per cent, in real terms, by 1982 on account of the predicted increases in the real costs of waste collection and, especially, disposal. For this reason, and also on account of the increasing use of non-returnables and the fall in trippage that is forecast to occur by 1982, the total external waste management costs of carbonated beverage containers for 1982 in the 'No action" scenario II are predicted to rise to about £18.3m under the average cost measure, and about £5.4m under the marginal cost measure (1977 prices). Section 5.7 shows that increases in the market share <u>and</u> trippage of the returnable bottle could result in reductions in the quantities of beverage container waste generated annually. The implementation of mandatory deposits on carbonated beverage containers, as depicted in scenario VII, would result in the volume of beverage containers in domestic waste being reduced by 54 per cent to 629,000 m^3 per annum. This would yield savings in waste management costs of about £3.32m per annum (1977 prices), which would represent about 0.7 per cent of the estimated total costs of collecting and disposing of domestic waste in the U.K.

CHAPTER 6

LITTER

Introduction

Concern over littered beverage containers was the principal motivation behind the 365 bills dealing specifically with beverage containers, which have been proposed in the U.S.A. at the national, state and local level. [Legislative Analyst for State of California (1975)][1]. However, it has been argued that this American experience concerning litter is not applicable to the U.K. situation. Therefore, this chapter examines, in the context of the U.K. situation, the impacts of littered beverage containers. The chapter consists of eight main sections:

- The first section, 6.1, outlines the definition of litter that is adopted in this thesis.
- Section 6.2 examines whether the impacts of litter constitute external costs.
- Section 6.3 first develops a 'best available' methodology for the evaluation of the external costs of litter. This section then outlines and explains the rationale for the 'best practicable' methodology that is adopted for this aspect in the ensuing sections.
- Section 6.4 reviews the available information on the external costs of litter.
- Section 6.5 assesses the size of the beverage container component of litter.
- Section 6.6 then estimates the unit external litter costs of the individual returnable and non-returnable beverage containers for carbonated beverages.

(1) The most notable of these bills are the Oregon Bottle Bill and the Washington Litter Tax (see Appendix I).

- Section 6.7 examines the relative littering levels of the alternative containers.
- The final section, 6.8, presents a qualitative assessment of whether more or less beverage containers would be littered under the various scenarios for 1982.

6.1 Definition of litter

In this thesis, litter is defined as discarded material that is not immediately placed in the recognised system of waste disposal and collection (e.g. the householders' dustbins). Thus, litter comprises the materials that people discard in public areas. This is similar to the definition adopted in other studies [e.g., Staudinger (1970), Cranston (1972), Tanner (1974), Merseyside County Council (1975)]. A distinction is made in this thesis between 'man-made' litter that is discarded as a result of human activity, and the 'natural' litter (e.g., leaves) that the authorities in urban areas have to collect.

6.2 The external nature of the impacts of litter

Littered materials create social damages in two forms:-

(i) the expenditures of the local authorities and parks departments on the control and collection of litter;

(ii) if the litter is not picked up - or until it is picked up - in the form of the aesthetic eyesore and public nuisance caused by litter.

The impacts in both of these two categories constitute external costs. The latter category since it comprises the adverse impacts of littered material on other members of society which the individual litterer did not take into account when he discarded the material. For the first category, even though the financial costs of litter control are paid for by householders through general taxation, they still constitute 'external' costs because they are borne by all taxpayers in a flat rate manner (usually a fixed sum on the rates) that is not related to the amount of litter discarded by an individual householder(2). Under this payment system, there are no incentives or penalties to discourage the individual from littering an article and therefore the financial costs of cleaning up the littered materials are 'external' to the individual's action of littering.

Current efforts to discourage littering are directed through anti-litter education and advertising campaigns and through the anti-litter laws. However, there are severe problems over enforcing the anti-litter regulations which are considered to be generally ineffective by those bodies actively concerned with litter control. [e.g., see Abrams (1967), Tanner (1974), Pontin (1975), Keep Britain Tidy Group (1979), Scottish Development Department (1980)]. The Scottish Development Department also states that advertising and publicity campaigns have only ephemeral impacts and do

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(2) The reasons for the external nature of the financial costs of litter control are similar to the reasons for the external nature of the financial costs of general solid waste management, which were discussed earlier in Chapter 5. Therefore, only the points that are particularly relevant to the litter question have been stated above.

not lead to any appreciable permanent reductions in litter [Scottish Development Department (1980, p.13)].

6.3 Methodologies for evaluating the external costs of littered beverage containers.

The external financial control costs of litter should be evaluated by determining the costs incurred by the authorities engaged in litter collection and control and then ascertaining the proportion of these costs that can be attributed to 'man-made' as opposed to natural litter. Data on the beverage container component of 'man-made' litter, along with additional qualitative information on particular problems caused by beverage containers, could then be used to estimate the external financial control costs attributable to littered beverage containers. This methodology formed the basis for the analysis of this aspect in this thesis.

However, the control of litter covers a variety of activities that are undertaken by a large number of public authorities and private organisations, many of whom do not keep detailed data on their expenditures related to litter control. Consequently, it is difficult to determine, with any definite precision, the total national expenditure on litter control. At present, it is only possible to make an approximate estimate of litter control expenditures on the basis of the limited data and information currently available on the costs of various litter control activities. If a more accurate estimate should be required, then it would be necessary to undertake an in-depth investigation of a representative sample of the various bodies engaged in litter control.

The first step in the evaluation of the aesthetic costs of litter is to identify the types of impacts caused by litter. It would be worthwhile to consider separately the injuries caused by litter and the aesthetic visual impacts of litter. For the evaluation of the injury costs, data would have to be provided on the number of injuries to humans and animals caused by litter, along with information on the seriousness of these injuries. Estimates would then be required on the costs of the various types of injuries, in terms of medical costs, time-off work and any pain and inconvenience caused by the injury. Cost estimates for the first two items could be obtained from hospitals, while consumer surveys could be used for the last item. Alternatively, the Department of Transport's standard value for a slight accident might be adopted. [see Department of Transport (1982)].

For the evaluation of the aesthetic visual impacts of litter, travel cost models might be considered. However, the impacts of litter occur not only in rural recreation areas but also in urban areas (e.g. urban streets, shopping centres and parks). It was noted in Chapter 3 that the successful performance of travel cost models was particularly difficult for urban sites that do not have a readily identifiable catchment area. Therefore, travel cost models would not be appropriate and consumer surveys are probably the best technique for valuing these impacts.

It would be necessary to question visitors at a representative sample of sites where the impacts of litter can arise. These questions should be designed to ascertain the respondents' valuation of the impacts of litter in general and the particular impacts of littered returnable and non-returnable beverage containers (e.g. their valuation of the visual impacts of littered cans as opposed to any injuries caused by littered returnable and non-returnable bottles). In addition, the survey could ascertain the respondents' opinion concerning the size of the carbonated beverage container component of total litter. Care would have to be taken to ascertain the extent to which the respondents' valuations took into account the injury and control costs of litter, which could be measured separately, so as to ensure that no double counting occurred.

Surveys of actual visitors to a particular site would mean that the questions were more realistic and more easily understood by the respondents. However, the grossing-up on a per capita basis of the respondents' average valuation might yield an overestimate for the national costs of the aesthetic impacts of litter, since the visitors to the sites may not be representative and, in particular, not all the population may visit the sites. Consequently, some information would have to be provided on the number and type of littered sites in the country and the proportion of the total population frequenting these sites or assumptions would have to be made for these factors. This might be achieved by surveys of general householders, which would also enable incorporation of any option value type impacts.

This thesis performs the first stage of this evaluation - the identification of the types of aesthetic impacts caused by litter. Systematic records are not kept of the aesthetic impacts caused by litter. Neither have any detailed consumer surveys yet been undertaken to value the aesthetic impacts of litter. It is apparent that litter creates social costs in many diverse places, ranging from rural national parks and beaches to urban streets, parks and housing estates. It would not have been feasible to perform sufficient in-depth surveys that could form a representative sample. Consequently, a monetary evaluation of the aesthetic impacts of litter could not be made. Instead, this thesis presents the results of some limited consumer surveys and reports the opinions of the authorities on the significance of the aesthetic impacts of litter, in general, and any particular problems caused by beverage container litter. If a more detailed economic evaluation of these impacts was required, then the methodology outlined earlier could be used for this.

6.4 The external costs of litter

6.4.1 Expenditures on litter control

The Keep Britain Tidy Group (1979) estimates that expenditure on street cleansing by local authorities (LA's) in the United Kingdom amounted to more than £100m per annum in 1978 (1978 prices). To this figure must be added the costs of a number of other litter control operations including:-

(i) The expenditures by the LA's Housing Department on the collection of litter from their housing estates;

(ii) Expenditures by the LA's Recreational and Cultural Services Department who purchase and service the litter bins and collect the litter discarded in urban parks. The Park Keepers estimate that collection of litter takes about an eighth of their time;

(iii) The operation of the Civic Amenity Waste Sites by the authorities(3)(4). This was estimated to cost about £6.89m in 1977-78 [Society of County Treasurers (1977)];

(iv) The clearing of litter from motorways and major roads. This is undertaken by the highway authorities;

(v) The control of litter in the rural parks by the Forestry Commission and the National Park authorities. It is estimated that these litter control activities cost about £170,000 in 1978 (1978 prices)(5);

(vi) The litter control campaigns performed by the Keep Britain Tidy Group and by various local

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(3) In an earlier report to the Waste Management Advisory Council [Fisher (1979)], the Management of Civic Amenity Wastes was not included in the list of litter control operations relevant to the beverage container issue since it was originally thought that civic amenity wastes do not normally include waste beverage containers. However, one waste disposal authority commented that apparently many beverage bottles and cans are brought to the Civic Amenity Waste Sites (e.g. as a result of parties, etc.).

(4) One further 'litter' cleaning activity is also undertaken by the LAs: gulley cleaning. However, this activity has not been included in the above list since it is considered that the cleaning of gulleys and drains is necessary on account of the presence of natural litter (e.g. leaves and dust) and not littered beverage containers. Natural litter, particularly leaves in autumn, also forms part of the materials collected from urban streets and parks.

(5) This estimate was derived on the basis of personal communications with officials at the Forestry Commission (New Forest), the Peak District and Lake District National Parks.

authorities. In 1976, the Keep Britain Tidy Group's total expenditure was £285,000 (1976 prices); [Keep Britain Tidy Group (1976)];

(viii) In addition, litter clearing activities are undertaken by various other authorities, such as the Port of London Authority who spent an estimated £170,000 in 1976 (at 1976 prices) on the collection of litter along a 30 mile stretch of the Thames [Manchester Evening News (1977)].

On the basis of the above information and consultations with the LA's Cleansing, Recreational and Cultural Services departments and with Forestry Commission and national park officials, it is estimated that the total costs incurred for the control of litter in the U.K. were in the region of £113m per annum, or about £2 per annum per head of the population in 1977-78 (1977 prices). Little data are currently available on the average costs (per ton) of collecting litter, but it is considered that these costs exceed the costs (per ton) of collecting general domestic solid waste. This is an important reason why the authorities are concerned about littered material that is discarded outside the recognised system of waste disposal.

Some of these litter control operations and expenditures are primarily related to the control and collection of 'man-made' litter. Such 'man-made' litter control activities include: the management of civic amenity waste sites; the control of litter in rural parks; the clearing of motorways; national and local litter prevention programmes; and some other litter clearing activities, such as those undertaken by the Port of London Authority.

However, the litter collection operations performed by the local authorities' street cleansing, housing and recreational services departments entail the collection of natural litter, such as sticks and leaves (especially in the autumn), as well as 'man-made' litter. The Keep Britain Tidy Group (1979) report the estimate of the general manager of Dundee's Cleansing Department that total expenditures on street cleansing could be reduced by 36 per cent if there was no 'man-made' litter. The addition of this figure of 36 per cent of the LA's total expenditures on litter plus the expenditures for the 'man-made' litter control activities, noted above, gives a tentative 'guesstimate' of £50m per annum for the national expenditure on litter that can be attributed to 'man-made' as distinct from natural litter.

It is even more difficult to obtain any estimate for the <u>marginal</u> costs of collecting and controlling 'man-made' litter. Enquiries with one local authority's cleansing department revealed that their litter collection schedules are organised so that the frequency with which street cleansing is undertaken in certain areas of the city is related to the different quantities of litter generated in various areas. These schedules of collection frequencies are reviewed in the light of any changes in circumstances so as to ensure an efficient allocation of litter collection efforts. Therefore, if there was a significant change in the quantity of material littered, then this would lead to a rescheduling of litter collection efforts which could affect the levels of the uncollected 'residual' litter left in public areas. Alternatively, it might result in some reduction in street cleansing costs, of which labour costs account for about 80 per cent of the total, or at least enable the local authorities to contain any increase in litter control expenditures in line with the central government's directive that local authorities must hold down their expenditure levels [Flintoff (1978)]. The officials at the parks departments consider that reductions in the quantity of materials littered would not have any noticeable effect on their financial expenditures, but would enable the park wardens to devote more time to maintaining and running the parks and would reduce the aesthetic impacts of litter. On account of the current paucity of financial data, it has not been possible to derive any quantitative figure for the marginal financial costs of litter control. Nevertheless, it can be said that reductions in 'man-made' litter would yield a reduction in the aesthetic impacts of litter.

6.4.2 The Aesthetic Impacts of Litter

The aesthetic impacts of litter comprise the injuries to humans and wildlife caused by littered items and the eyesore created by litter.

Lidgren (1983) reports the findings of a government investigation in Sweden that, over the period April-September 1968, about 25,000 people and 3,500 dogs were injured by littered items. He suggests that the costs of such an injury to a human and a dog were 500 SKr. and 50 SKr., respectively, in 1973, so that the total costs of these injuries amounted to about 13 million SKr. (1973 prices). These cost estimates were based upon enquiries with hospitals. They include the financial costs of medical treatment and any time required off work but do not include any pain and inconvenience caused by the injury. Lidgren (1983) also reports the Swedish Agricultural Institute's estimate that the costs of injuries to animals and damage to agricultural machines caused by litter amounted to about 3 million SKr. in 1973 (1973 prices). This yields a total financial cost for these impacts of litter, in Sweden, of about 16 million SKr. (1973 prices). This is equivalent to about £3 million (1977 prices).

Some cases and complaints concerning such impacts have been reported for the U.K. [e.g., see Lewis (1975)]. However, systematic data on such cases are not currently kept in the U.K., and therefore it is not possible to determine a quantitative measure, especially in monetary terms, of these impacts for the U.K. Nevertheless, the findings of opinion surveys demonstrate that there is considerable public concern over litter which was identified by the respondents as one of the major environmental problems that they experienced. [Liverpool City Council (1971), Civic Trust for the North West (1971), Keep Britain Tidy Group (1974), Social and Community Planning Research (1975), British Tourist Authority (1976), Keep Ireland Beautiful (1976)].

6.4.3 Trends

One study showed that, over the five-year period 1972 to 1977, there was a 43 per cent drop in the quantity of material littered [England et al. (1978)]. However, it is the opinion of the official bodies engaged in litter control (e.g. National and local park officers etc.) that the volume of litter is rising, as are the costs of collecting the discarded materials, and that there is increasing public concern over litter.

6.5 The size of the beverage container component of litter

6.5.1 The results of four litter surveys

Four surveys of the composition of litter have been undertaken in the U.K. [England et.al. (1972, 1978), Fisher (1977, 1979)]. These surveys found that 'carbonated' beverage containers constituted between 5-31 per cent of the total litter found in these four surveys(6) (see Table 6.1).

6.5.2 Critical appraisal of the litter surveys

On account of the wide variation in the figures given by the four surveys, it is necessary to examine in some depth the characteristics of the areas surveyed, the frequency of litter collection in each survey area and the different definitions and procedures adopted in the separate surveys.

6.5.2(i) Characteristics of the Survey Areas

Litter occurs and creates social costs in many diverse places (e.g. National Parks and Recreation areas,

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(6) These four surveys also revealed that containers for all beverages (including wines, spirits, cordials, fruit juices and milk, as well as beer, cider and carbonated soft drinks) constituted between 7-27 per cent of all the littered items analysed. The surveys in the New Forest and Leicester showed that such total beverage container litter constituted 30-36 per cent of the total volume and 46-49 per cent of the total weight of the litter analysed [Fisher (1977), (1979)].

Table 6.1

Carbonated beverage container litter as a % of the total litter found in 4 Surveys

Litter Survey		Year performed	Total No. of littered items analysed	Carbonated beverage container litter % of total litter (Measurement base used in survey)		
				(Unit Count)	(Volume)	(Weight)
(I)	GMF_1	(1972)	29,383	4.9	-	-
(II)	GMF_2	(1977)	17,899	5.3	-	-
(III)	New Forest	(1977)	3,045	11.5	21.5	27
(IV)	Leicester	(1978)	3,993	18.1	31	31
	Total amount of litter analysed in surveys (I)-(IV)		54,320			
	Aggregated average of (I)-(IV)(1)			6.4	27	29

Source: (I) England et al (1972), Glass Manufacturers Federation (GMF) (1973)
(II) England et al (1978)
(III) Fisher (1977)
(IV) Surveys undertaken by the author in 3 urban parks in Leicester at 2 different time periods.

(1) The aggregated averages have been calculated using, as weights, the total amount of litter analysed in each of the surveys.

beaches, urban parks, urban streets, housing estates etc.). The quantity and nature of the litter in each location varies depending upon a number of factors including its concentration of population, level of tourism etc. This variation in the composition of litter means that, while it is not feasible to undertake litter surveys at all of the various locations, it is necessary to utilise information from as wide a data base and from as many areas as possible so as to yield the most representative estimate possible.

The litter at about 50 sites in various parts of the country was examined in each of the GMF surveys. These sites included 9 beaches, 10 beauty spots, 21 lay-bys and 10 parks, six of which were in major cities [England et al (1978)]. A greater weight has been given to these more extensive GMF surveys in the calculation of the aggregated average shown on the bottom line of Table 6.1.

The survey in the New Forest analysed the litter from just one specific tourist area and Fisher (1977, p.10) concludes that:

> "This survey is based on just one tourist area. It is difficult to estimate the effect of the particular circumstances of the survey's location - New Forest. In order to verify the findings of this one survey, it would be desirable to follow it up with surveys of other areas and situations".

Furthermore, it had been suggested that the use of beverage containers would be (relatively) greater in such recreational areas than in urban areas, so that this single survey might overestimate the size of the beverage container component of litter. A detailed analysis of the data in the

GMF survey in England et al (1972) revealed that the carbonated beverage container component of litter was lower at the lay-by and urban park sites which gave some support to this hypothesis.

Therefore, a further survey was undertaken of the litter collected, at two different time periods, from three parks in Leicester[7]. These follow-up surveys in urban parks, along with the GMF surveys, do at least enable incorporation of some important roadside and urban litter. Nevertheless, this urban litter did still come from urban recreational parks so that all four surveys still primarily relate to recreational sites in rural and urban areas, and all the surveys were performed in the summer. It was not possible to analyse litter from urban streets to be able to overcome completely this possible limitation of the surveys. However, it is apparent that there is more concern over the greater quantities and impacts of the 'man-made' litter arising in recreational areas during the summer and, consequently, the limited resources available for litter surveys were concentrated upon these aspects.

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(7) Table 6.1 shows that the beverage container component of the litter analysed was actually higher in the Leicester Urban Parks Survey than in the New Forest survey. However, these results probably give support to the earlier statement that the composition of litter can vary significantly between different locations rather than disprove the hypothesis that surveys of recreational litter overestimate the size of the beverage container component of litter.

6.5.2(ii) <u>The frequency of litter collection in each survey area</u>

Beverage containers are more permanent than most items of litter since they do not biodegrade like paper. Therefore, the OECD report [OECD (1978)] notes that the size of the beverage container component could be expected to be higher in the litter that had accumulated over a period of time than in litter that was recently discarded. Such recently discarded litter was analysed in the GMF surveys, while litter that had accumulated throughout the year was analysed in the New Forest survey. Therefore, this factor might partly explain the lower figure given by the GMF surveys, although recently discarded litter was analysed in the Leicester urban parks survey which gave the highest figure for the size of the beverage container component of litter.

Recently discarded litter will give a better indicator for the financial costs of collecting litter, while accumulated litter will give a better index for the aesthetic impacts (e.g. injuries to humans and animals) of the residual litter that is not collected.

6.5.2(iii) <u>The definitions and procedures adopted in each survey</u>

There are three aspects concerning each survey that will affect the results. These three aspects are:-

(I) definition of litter;

(II) definition of beverage related litter;

(III) survey method and measurement base used.

Definition of litter. In the New Forest survey, a detailed analysis was undertaken of all the material in a random sample of 21 bags of litter collected by volunteers in the New Forest's annual "Cleansweep Operation". The volunteers could be expected to have picked up all the visible litter that they felt was creating a problem for the community. Therefore, the litter collected should represent well the potentially damaging litter there that was of concern to the public. In the Leicester urban parks survey, a detailed analysis was undertaken of a sample of all the litter that the park keepers had picked up during their normal litter collection activities. The litter in the Leicester Urban parks surveys should therefore represent well those littered items that are of concern to the public and the park keepers and also the litter that the authorities spend time and money to collect[8]. Thus the litter analysed in these two surveys conforms well with the definitions of litter and the external costs of litter, given earlier.

The GMF surveys were based upon a visual inspection of litter at the various sites. This method would include those items of litter that create an aesthetic eyesore but might miss some small pieces of litter which could still cause damage and injuries. All four surveys only analysed litter that was on the ground. They did not include the litter in litter bins.

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(8) Natural litter (e.g., leaves, sticks, etc.) was included in the litter count in the survey in Leicester but not in the New Forest survey since natural litter is not relevant for rural locations.

Definition of beverage-related litter. In the New Forest and Leicester Urban Parks surveys, all beverage related materials were included - i.e., bottles, cans, their supplementary packaging and closures (bottle tops and ring pulls) and pieces of broken glass (of all sizes). In the GMF surveys, cans and bottles were included and large pieces of broken bottles were counted together as one bottle, but supplementary packaging, discarded ring pull closures for cans, bottle tops and small pieces of broken glass were not included. This last omission could account for the lower figure for beverage related litter in the GMF survey since broken glass constituted a much larger proportion of the beverage related litter that was counted in the New Forest and, especially, the Leicester Urban Parks surveys. Thus, carbonated beverage related broken glass represent about 3 per cent of all the items of litter analysed in the New Forest survey and 8 per cent of the litter in the Leicester survey, while pieces of broken bottles for carbonated beverages represent only 0.3-0.4 per cent of the litter in the GMF surveys[9]. Similarly, discarded ring pull closures for cans and bottle tops accounted for about 0.5 per cent of the littered items analysed in the New Forest and

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(9) Some breakage of the glass bottles might have occurred during the collection and sampling of the litter in the New Forest and Leicester Urban Parks surveys, although it is considered that such breakages would not have been substantial so that these surveys should not give a significant overestimate for broken glass. The Ontario Solid Waste Task Force of Ontario reported that broken pieces of glass represented 25 per cent of all the littered items analysed in a survey in Ontario [see Ontario Solid Waste Task Force (1974)].

Leicester surveys, while these items were not included in the GMF surveys. This indicates that the GMF's surveys' estimates for the size of the carbonated beverage container component of litter should be revised upwards from 5 per cent to about 10 per cent to allow for these omissions. The aggregated average for the carbonated beverage container component of litter in all four surveys would then become about 11 per cent.

Survey method and measurement base used. In the New Forest and Leicester Urban Parks surveys, the collected litter was hand sorted into 38 categories and counted on an item by item basis with each piece of litter, however big or small, being counted as one item. The litter in each category was then put into sacks which were gently shaken down but not compressed. At the completion of the sorting, the number and weight of full and part-full sacks were recorded(10). This procedure was more thorough than the visual inspection adopted in the GMF surveys which only measured litter on an item count basis.

Beverage containers are larger and heavier than most items of litter. Therefore, the size of the beverage container component of litter is greater when measured by volume or weight, than when an item count measure is adopted. The OECD report [OECD (1978)] suggests that this volume measure reflects better the visual impact of litter.

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(10) Further details on the procedures adopted in the New Forest and Leicester Urban Parks surveys are given in Fisher (1977).

However, even the volume measure may fail to pick up fully the aesthetic impacts of some components of litter.

Leonard and Moseley (1973) report the findings of an opinion survey of beach visitors concerning the type of litter they consider to present the major problem. Table 6.2. reproduces their results. They found that 62 per cent of the respondents considered bottles to be the main type of litter and 63 per cent regarded cans as the main type of litter. Leonard and Moseley (1973, p.10) go on to suggest that:-

> "Bottles and tins are the two classes of litter that cause a disproportionate amount of concern relative to the quantities visitors have to dispose of"

Most of the littered cans and many of the bottles would be carbonated beverage containers. This indicates that the public's opinion on the contribution of beverage containers to total litter is greater than that given by the physical percentages. A similar conclusion was reached by Stern et al (1975) and the OECD report [OECD (1978)].

Therefore, it is also necessary to take into account any particular problems caused by littered beverage containers. These include injuries to humans and animals as a result of littered bottles, broken glass, torn cans and ring pulls, and the extra visual impact of a bright beverage container. This latter aspect highlights an essential conflict between the beverage container's role of sales promotion on the supermarket shelves and its visual impact when littered.

Table 6.2

Type of litter that visitors regard as the main problem

Type of litter	Number mentioning this type of litter	% of total replies
Bottles and tins	65	18
Bottles and glass	55	15
Bottles and paper	42	12
Bottles, tins and paper	59	16
Paper and wrappers	55	15
Paper and tins	40	11
Tins	24	7
Plastic containers	8	2
Others	13	4

Source : Leonard and Moseley (1973)

In relation to the first aspect, some cases of injuries to humans resulting from broken glass have been reported and some data relating to Sweden were given earlier [see Lidgren (1983)]. However, no documented records are kept in the U.K. on this subject. The National Park authorities and the Neighbourhood Organisations Committee of Liverpool Council have expressed concern over the injuries and damage that can be caused by bottles, broken glass, torn cans and ring pulls and some authorities have expressed particular concern over non-returnable beverage containers [Liverpool City Council (1971), Peak District National Park (1977, 1978)]. Enquiries with local and national parks departments revealed that their litter collection teams find broken glass and ring pulls more difficult to pick up than ordinary litter and that bottles and cans create difficulties for their park management activities (e.g. mowing).

To sum up: the four litter composition surveys do usefully complement each other. The two GMF surveys are more representative with their coverage of a wider number of areas and their larger data base; while, in the New Forest and Leicester Urban parks surveys, the litter from these specific areas has been analysed more thoroughly and the relevant volume measure has been used. These surveys indicate that 'carbonated' beverage containers constitute about 27 per cent of the total volume and 29 per cent of the total weight of littered material and about 11 per cent of the total number of items littered. All four surveys relate mainly to recreational sites in urban or rural locations and all the surveys were performed in summer. It is likely that the surveys give an overestimate for the beverage containers' component of total 'man-made' plus natural litter. However, there is greater concern over the impacts of 'man-made' litter discarded in such recreational areas during the summer and these four surveys yield a fairly reliable physical indicator of the beverage container component of this important 'man-made' litter. In addition to these physical measures, it is important to note that many authoritative bodies engaged in litter control have expressed concern over the particular problems caused by littered beverage containers.

6.6 The external costs of littered beverage containers

The previous section assessed the size of the beverage container component of litter under a number of alternative measures of litter. The ideal measure should be that which reflects best the social costs of litter. This is difficult to achieve in practice but can be approached by splitting the social costs of litter into two components: the financial costs incurred for the control and collection of litter; and the aesthetic impacts of discarded material. A combination of the quantitative measures adopted in the four litter surveys, along with some additional information on the impacts of littered beverage containers, does enable the derivation of a reasonable, albeit tentative, indication of the beverage container's contribution to these two components.

6.6.1 <u>The financial costs of litter control</u>

The OECD report [OECD (1978, p.53)] states that:

> "The costs of litter collection are determined more by the pieces of litter to be picked up than by volume or weight."

Therefore, the estimation of the beverage containers' contribution to the financial costs of litter control is based more upon the litter surveys' results under the item count measure than under the volume or weight measures of litter. In addition, it is necessary to take into account that litter collection teams find pieces of broken glass and ring pulls particularly difficult to pick up. On the basis of these considerations, it is estimated that carbonated beverage containers contribute about 18 per cent of the total costs of collecting 'man-made' litter.

Section 6.4 suggested that the total costs attributable to collecting and controlling man-made litter were about £50m per annum. Therefore, the carbonated beverage containers' contribution of the financial costs of litter control would be about £9m per annum.

In Table 6.3, this sum has been allocated between the returnable and non-returnable containers in proportion to the total numbers of returnable and non-returnable carbonated beverage containers found in the GMF_2 litter survey and the surveys performed in the New Forest and Leicester. This shows that the total annual litter control costs attributable to littered returnable bottles, non-returnable bottles and metal cans are be about £1.26m per annum, £1.7m per annum, and £6m per annum, respectively (1977 prices). These figures have then been divided by the 'off' premise sales of carbonated beverages in each container to indicate that the unit external litter control costs per individual returnable bottle, non-returnable bottle and metal can are of the order of 0.11p, 0.21p and 0.25p, respectively (1977 prices).

However, it must be emphasised that the data presented above is subject to a number of limitations. First, as was pointed out in section 6.4, little data are available on the total national costs of litter control and, especially, the costs attributable to controlling 'man-made' litter. The figure used above is based upon the experience and opinion of just one local cleansing department and therefore can only represent a very tentative estimate.

Second, section 6.5 highlighted certain limitations associated with the litter composition surveys. An estimate of the costs of controlling just 'man-made' litter was used in the calculations to overcome the possible limitation that the litter surveys, being undertaken principally at recreation sites and in the summer, might overestimate the size of the beverage container component of total (man-made plus natural) litter. Nevertheless, the data presented in table 6.3 is still subject to the other limitations identified earlier in section 6.5.

These limitations mean that the specific figures presented above could be subject to a considerable degree of error. Therefore, Table 6.3 also gives a range of possible values for the litter control costs of returnable and non-returnable beverage containers and it is probably more meaningful to consider the unit external costs of the containers for carbonated beverages as lying within these ranges.

No data were available on the marginal costs of controlling litter to enable calculation of the unit external litter control costs of beverage containers under the marginal cost measure of control costs.

6.6.2 The aesthetic impacts of littered beverage containers

The volume measure of litter is the best available physical indicator for these aesthetic impacts. Section 6.5 revealed that carbonated beverage containers constitute about 27 per cent of the total volume of litter analysed in the New Forest and Leicester surveys. However, this figure of 27 per cent only represents a minimum estimate for the carbonated beverage containers' contribution to the aesthetic costs of litter on account of the extra visual impact of a bright can

Table 6.3 The external litter control costs for returnable and non-returnable containers for carbonated beverages (1977 prices)

Type of Beverage Container	N°. found in the 3 litter surveys(2)(3)(4) N°.	(% of Σ)	Share of litter control costs - £m. per annum -	(range)(1)	'OFF' Premise(3) sales of carbonated beverages -10^6units-	Unit Costs of litter control -pence per container-	(range)(1)
Returnable Bottle	279	(14%)	1.26	(0.7-1.8)	1123	0.11	(0.06-0.2)
Non-returnable Bottle	363	(19%)	1.71	(1.0-2.5)	815	0.21	(0.12-0.3)
Metal cans	1316	(67%)	6.03	(3.4-8.7)	2437	0.25	(0.14-0.4)

Source: As in Table 6.1
+ Metal Box Market Research Division for 'off' premise beverage sales quantities
+ Keep Britain Tidy Group (1979) for litter control costs.

(1) A range for the total and unit litter control costs is also given in brackets on account of the uncertainty surrounding the available data on both litter control costs and also the 'off' premise sales figure that has been used as the divisor (see text).

(2) In the litter surveyed, there were some bottles and pieces of broken glass which could not be identified as belonging to a specific category of beverage container. This unclassified littered glass was apportioned between the various beverages and between the alternative containers in proportion to the number of identified pieces of glass that were found for each of the categories.

(3) The data from the GMF_2, New Forest and Leicester urban parks litter surveys, and not the GMF_1 survey as well, are presented in table 6.3 so that the three data sources used for the calculations should be as consistent as possible. Thus the data for 'off' premise beverage sales refers to 1977 and the data on litter control costs relates to 1977-78. The GMF_2 and New Forest litter surveys were undertaken in 1977 and the Leicester urban parks survey was undertaken in 1978, while the GMF_1 survey was undertaken in 1972.

(4) This comprises the littered items relating to the respective types of beverage containers (i.e., whole bottles, broken glass, cans and - for the surveys performed in the New Forest and Leicester - the closures and supplementary packaging as well). In the New Forest and Leicester surveys, all these items have been counted as separate units.

and the injuries and damages caused by bottles, broken glass, torn cans and ring pulls. It is evident from public opinion surveys and enquiries with the authorities engaged in litter control that there is considerable concern about littered beverage containers which are perceived to cause a major part of the aesthetic impacts of littered materials. Data constraints prevented the derivation of a meaningful monetary valuation of these impacts of littered beverage containers and this is an important gap in the currently available data on this subject.

6.7 The relative littering levels of the alternative beverage containers

6.7.1 Findings of the litter surveys

This section examines whether returnable bottles are littered more or less frequently than non-returnable bottles and cans. Table 6.4 gives the number of beer, cider and carbonated soft drinks bottles and cans found in the GMF_2 survey, and the surveys performed in the New Forest and Leicester. This shows that many more non-returnable cans and bottles were littered than returnable bottles. However, on their own, these absolute quantities are not very meaningful since more beer and soft drinks are sold in cans than bottles and more are sold in returnable bottles than in non-returnable bottles. Hence, the absolute quantities are not truly comparable. Therefore, the numbers of each container type found in the litter surveys have been divided by the 'off' premise sales of beer, cider and soft drinks in that container type in 1977 to yield the littering ratio shown in column 3 of table 6.4. This then yields the relative litter ranking index (RLR) for the alternative containers, shown in column 4, which indicates whether more or less bottles or cans are littered as a result of the sale of beverages in returnable or non-returnable containers.

Table 6.4 shows that the non-returnable cans are littered about 5 times as frequently as the returnable bottle and that the non-returnable bottles are littered about twice as frequently as the returnable bottles. This indicates that the convenience characteristics of the disposable one-way containers result in a greater littering of this type of container, especially the can; while the incentive to return a returnable bottle results in a lower littering rate for the returnable. Thus, as well as being a 'behavioural' or 'people' problem, litter may also be a 'product' problem. The 'product' problem is related to the 'people' problem to the extent that the current growth of disposable products results in the development of a disposable and less litter conscious attitude among consumers.

6.7.2 Critical appraisal

Table 6.5 presents the relative litter ranking indices (RLRs) for the alternative beverage containers found in each of the three litter surveys. The variation in the littering ratios of these three surveys is due to differences in the characteristics of the areas surveyed and the different procedures followed in the separate surveys.

It was noted earlier that the GMF_2 and the Leicester Urban Parks surveys related to litter that had recently been discarded, while the New Forest survey examined

Table 6.4

The distribution of the carbonated beverage container litter found in three litter surveys and the 'off' premise beer, cider and carbonated soft drinks sales in 1977 between the 3 alternative containers

GMF_2 (1977), New Forest (1977) + Leicester urban parks (1978) litter surveys[4]

Beverage Container	Nº. found in the 3 litter surveys (1)(2)(3)(4) (A)	'off' premise sales of beer, cider + soft drinks (million units)[5] (B)	Littering Ratio (A) ÷ (B)[5]	Relative Litter Ranking Index (RLR)[5]
Returnable Bottle	111	1123	0.1	(1.0)
Non-returnable Bottle	168	815	0.21	(2.1)
Non-returnable Can	1316	2437	0.54	(5.4)

Source: England et al (1978)
Fisher (1977) (1979)
Metal Box Market Research Division

(1) The broken bottles that were found in the GMF_2 survey have each been counted as single items since in this survey separate pieces of a bottle were counted as one bottle.

(2) This includes the bottle tops, ring pulls and supplementary packaging for the beverage containers and the pieces of broken glass that were found in the New Forest and Leicester Urban Parks litter surveys. These pieces of broken glass have been apportioned between the various beverages and the alternative containers in proportion to the number of identified pieces of glass that were found for each of the categories. In order to convert the broken glass into terms of the number of bottles that were originally littered, the total number of pieces of broken glass have been divided by ten. This is the same procedure and assumptions that have been used in other litter studies [e.g., Ontario Solid Waste Task Force (1974)].

(3) See Note (2) table 6.3

(4) See Note (3) table 6.3

(5) The RLR's are subject to some uncertainty and limitations on account of doubts over the validity of using the 'off' premise sales figures as the divisor for their calculation (see text).

litter that had accumulated over a period of time. The OECD report [OECD (1978)] suggests that the action of scavengers should result in a decline, over time, in the number of returnable bottles present in litter. However, Table 6.5 shows that the RLRs for the litter survey in the New Forest were similar to and, if anything, lower than those obtained in the other litter surveys. This suggests that, in the current situation for the U.K. beverage market, the scavenging of returnable bottles is not very widespread. Chapter 10 reports the results of some recent opinion surveys of consumers and retailers which indicate that this could be due to potential scavengers' lack of knowledge that certain bottles are deposit-bearing returnables and due to the difficulties they encounter in finding a retail outlet which will accept their returned bottles.

Table 6.5

The relative litter rankings of the alternative beverage containers found in the GMF_2, New Forest and Leicester Urban Parks Litter Surveys

Beverage Container	Relative litter Ranking Indices (RLR) for each Litter Survey (3)(4)(5)		
	GMF_2 (1)	New Forest (2)	Leicester (2)
Returnable bottle	1.0	1.0	1.0
Non-Returnable bottle	2.0	1.3	3.1
Non-Returnable can	4.2	4.8	11.1

Sources: As in Table 6.4

(1) See Note (1) Table 6.4
(2) See Note (2) Table 6.4
(3) See Note (2) Table 6.3
(4) See Note (3) Table 6.3
(5) See Note (5) Table 6.4

An earlier report [Fisher (1979)] critically analysed the RLRs for these three litter surveys in the light of the other differences in the characteristics of the areas surveyed and the differences in the procedures followed in the separate litter surveys. This report concluded that these factors would not significantly alter the overall rankings given earlier in Table 6.4.

However, some doubts have been expressed concerning the divisor used to derive the RLR figures. Earlier studies [e.g., Ontario Solid Waste Task Force (1974)] used the total beverage sales figures as the divisor. However, this was considered to be incorrect since these total beverage sales figures included both 'on' and 'off' premise sales. 'On' premise sales result in considerably less littering than 'off' premise sales and returnables form a large proportion of 'on' premise sales while cans are more likely to be used for 'off' premise sales. Therefore, the OECD report [OECD (1978)] went on to use 'off' premise beverage sales as the divisor. Similarly, in this thesis, 'off' premise sales were used in the calculations shown earlier in Table 6.4. Nevertheless, it is acknowledged that these estimates for 'off' premise sales may not represent perfectly the level of beer and soft drinks consumed in each container type at the various sites where the surveys were performed. The impossibility of obtaining such disaggregated data on beverage sales and consumption meant that it was necessary to use 'off' premise sales as the best available proxy measure.

However, it should be noted that it is likely that (relatively) more non-returnable containers, and especially cans, would be used for the consumption of beverages at the recreation areas surveyed. Therefore, the data presented in Table 6.4 will overstate, by an uncertain amount, the RLRs for the non-returnables, although the general conclusion, that non-returnable bottles and cans are likely to be littered more frequently than returnables, is probably still valid.

On account of this limitation, no attempt is made here to use the data presented in Table 6.4 to predict the quantities of bottles and cans that would be littered under the various scenarios for 1982. Instead, the following section presents a qualitative assessment of whether more or less bottles and cans would be littered under the different scenarios.

6.8 The levels of littered beverage containers under the different scenarios for 1982

Under the No action scenario II for 1982, the amount of littered beverage containers could be expected to rise[11] on account of two factors.

The first, and more important, factor is the predicted growth in the consumption of packaged beverages, and particularly the increase in the use of non-returnables. This would also result in an increased amount of litter arising under scenarios III and IV. The increase in litter

(11) The prognoses in this section assume constant levels of litter control.

being largest under the completely non-returnable situation of scenario III.

Second, the fall in the returnable's trippage, which is predicted to occur by 1982 under scenario II, could also result in an increase in the amount of littered returnables since the littering of a bottle is one of the possible leakages that can prevent the bottle from being re-used. Conversely, increases in the trippage could reduce the quantities of returnable bottles present in litter. This would result from two mechanisms. First, measures to facilitate and increase the return of bottles would mean that the consumer would be more likely to return the bottle rather than discard it. Secondly, (potential) scavengers would now be more willing and able to pick up any returnable bottles, that were still inavertently littered, and return them for the redemption of the deposit value. Therefore, the quantities of littered beverage bottles and cans could be expected to decline under the scenarios V, VII, VIII and IX. The decline would be greatest for scenarios VII, VIII and IX.

Scenario VII depicts a situation after the implementation of mandatory deposit legislation. The levying of mandatory deposits on all beverage containers is designed to penalise the individual litterer who forgoes the deposit he has paid on a container when he litters it. Hence, the OECD report [OECD (1978)] states that this goes a long way towards internalising the external costs of littered containers. Mandatory deposit legislation could also encourage and facilitate the collection and return of littered beverage containers by scavengers. Therefore, there is likely to be a particularly marked reduction in the number of littered beverage bottles and cans under this scenario. Beverage related litter fell by 66 per cent following the implementation of mandatory deposit legislation in Oregon [Applied Decision Systems (ADS) (1974)]. This represented a decline of 10.6 per cent in the total number of littered items and a decline of 21 percent in the total volume of litter. The ADS study also reported that, over the period analysed, there was an increase in non-beverage related litter. If this increase had not occurred, then the total number of littered items would have declined by almost 20 per cent following the implementation of mandatory deposit legislation.

6.9 Conclusion

This chapter reports and critically reviews four litter composition surveys which have been undertaken. This review shows that these surveys do usefully complement each other since two surveys have a larger and more representative data base, while the other two surveys have analysed more thoroughly the litter from specific locations. The surveys indicate that beer, cider and carbonated soft drinks containers constitute about 27 per cent of the total volume and 29 per cent of the total weight of littered material and about 11 per cent of the total number of items littered.

Analysis of the different types of beverage containers found in the surveys indicates that non-returnable bottles and cans are likely to be littered more frequently than are returnable bottles.

It is apparent, from public opinion surveys and statements by authorities engaged in litter control, that there is considerable concern over the aesthetic impacts of littered beverage containers, especially the visual impacts of bright cans and injuries from broken glass. Thus it is necessary to perform a comparative evaluation of the (possibly more serious) injury impacts of broken returnable and non-returnable glass bottles and the visual impacts of the probably greater amount of littered cans. Data constraints prevented the determination of a monetary valuation of these aesthetic impacts of littered beverage containers and this represents an important gap in the available information on this subject. Section 6.3 outlined a methodology that could be used to obtain an economic valuation of these impacts, although it is noted that considerable resources would be required for the performance of sufficient in-depth consumer surveys relating to a representative sample of littered sites.

Section 6.4 highlights the current lack of comprehensive data on the financial expenditures of the various bodies engaged in litter control, particularly for those expenditures incurred for the control of 'man-made' litter (i.e., litter discarded by humans or resulting from human activity). The available information suggests that the total costs of controlling and collecting litter were approximately £113m in 1977-78 (1977 prices). It is tentatively estimated that the costs attributable to the control of 'man-made' litter were of the order of £50m in 1977-78 (1977 prices). It is the opinion of the authorities engaged in litter control that these costs have been rising in recent years and that there is increasing public concern over the impacts of litter. The litter control costs attributable to carbonated beverage containers are estimated to be between £5-13m per annum (1977 prices). The unit external litter control costs for the individual containers are estimated to be between 0.06-0.2 pence per returnable bottle, 0.12-0.3 pence per non-returnable bottle and 0.14-0.4 pence per metal can. However, these estimates are subject to considerable uncertainty on account of the limitations of the available data. Consequently, ranges of possible values, rather than a precise figure, have been presented here.

It is considered that the amount of littered beverage containers will rise under the 'No action' scenario II, principally on account of the predicted growth in the sale of carbonated beverages in non-returnable containers. For similar reasons, the level of littered beverage containers is expected to rise under the completely non-returnable situation of scenario III. Increases in the market share <u>and</u> measures to facilitate and raise the return - or trippage - of bottles could result in a reduction in the amount of bottles and cans present in litter. Therefore, it is expected that the amount of carbonated beverage container litter would fall under scenarios V, VII, VIII, and IX, especially under the post-mandatory deposit scenario VII.

CHAPTER 7

POLLUTION EMISSIONS

Introduction

This chapter considers the pollution impacts of the alternative container systems, in the form of the emissions of air and water pollutants and the generation of industrial solid wastes.

- Section 7.1. defines the scope and nature of the external costs of the alternative beverage container systems' pollution emissions and identifies the ideal objective for the evaluation of these external costs.
- Section 7.2 first outlines a proposed 'best available' methodology for evaluating these external costs. There are a number of practical constraints which prevent the achievement of the ideal objective and precluded the performance of all the stages identified in this methodology. As a result, the analysis in this thesis had to be limited to the first stage - calculation of the pollution emissions generated by the beverage container systems. Section 7.2 then outlines this 'best practicable' methodology that was adopted for this analysis.
- Section 7.3 reviews the currently available data. No pollution emissions study has yet been undertaken for the U.K. beverage container systems. Consequently, overseas studies had to be used as the principal source of quantitative data for this section. However, it is acknowledged that these overseas studies do have certain limitations and may not provide definitive results for the U.K.
- Therefore, in section 7.4, these overseas' studies are critically analysed in order to identify their

limitations and to indicate in what way they are not applicable to the specific situation in the U.K. The data from one of the overseas' studies are accordingly adjusted to allow for the major differences between the container systems analysed in this study and the U.K. situation.

- Section 7.5 presents estimates of the levels of pollutants generated by the beverage container systems under the different scenarios.

7.1 The external costs of the pollution emissions from the beverage container systems

The external costs of this aspect are represented by the environmental damages resulting from the residual pollution emissions of the beverage container systems. Where the residual pollution emissions are the firms' emissions to the environment occurring after their treatment by any pollution control measures currently adopted by these firms.

The ideal objective in estimating these external costs is to evaluate the environmental damages caused by these residual pollution emissions. This evaluation should indicate the significance of the overall level of these external costs and also the relative levels of these external costs generated by the alternative beverage container systems.

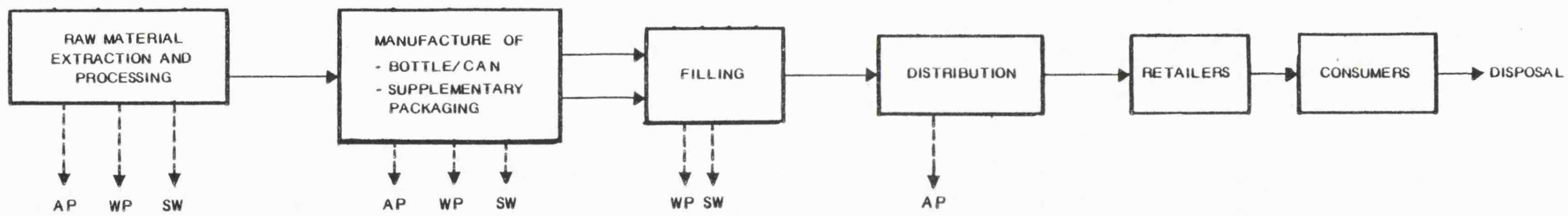
Figure 7.1 illustrates the various process stages of the alternative beverage container systems.

On account of the return and washing of the bottles, the returnable system generates more pollution at the filling and distribution stages. However, if the bottle is returned for re-use a sufficient number of times, then less raw materials will be required for the manufacture of new

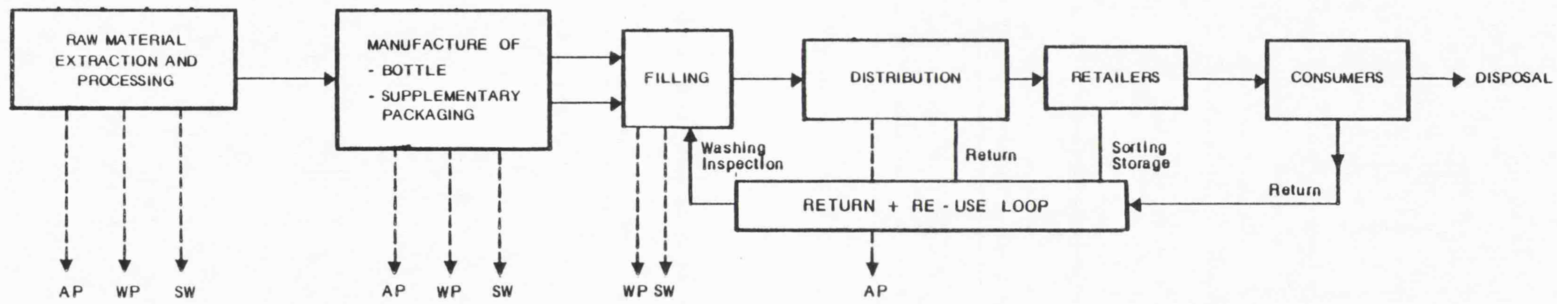
Figure 7.1

PROCESS STAGES IN THE RETURNABLE AND NON-RETURNABLE CONTAINER SYSTEMS FOR CARBONATED BEVERAGES

A. Non-Returnable Systems



B. Returnable Systems



Where

AP = Air pollution emissions.
WP = Water pollution emissions.
SW = Industrial Solid wastes.

containers under this system than under the non-returnable systems which may therefore generate more pollution from the extraction and processing of the raw materials and their manufacture into containers. Moreover, the alternative container systems involve different materials and various industrial processes, and the quantity and nature of the pollution emissions from the various processes can also differ considerably. Therefore, when comparing the alternative beverage containers, it is necessary to evaluate the pollution emissions from the total system of delivering a certain quantity of beverage in each of the containers - i.e., to consider all the stages from the extraction of the raw materials through to the final disposal of the container - and not to analyse just one of the stages or industrial processes.

7.2 Methodologies for evaluating the pollution impacts of the beverage container systems.

7.2.1 A proposed 'best available' methodology

A full evaluation of the impacts of the beverage container systems' pollution emission entails the following four sequential stages:-

(I) Calculation of the residual pollution emissions of the alternative beverage container systems.

(II) Conversion of the pollution emissions data into terms of their impacts on ambient environmental quality.

(III) Estimation of physical measures for the damages resulting from these environmental quality changes.

(IV) Monetary evaluation of these environmental damages.

(I) Calculation of the residual pollution emissions

Data would first be needed on the energy and raw materials requirements of the beverage container systems in the U.K. Some information for this could be obtained from Boustead and Hancock (1981).

The pollution coefficients for each of the process stages would then have to be determined. The data on the pollution coefficients used in the US EPA (1974) study could perhaps be used for this(1). However, these pollution coefficients were compiled in 1974 and are unlikely to represent accurately the current U.K. position.

Therefore, it is preferable to obtain U.K. data for the pollution coefficients. Such information could be obtained by adopting the following procedure(2):-

(i) Identify the processes in the alternative beverage container systems - [from information in Boustead and Hancock (1981)];

(ii) Estimate the raw (untreated) pollution load from each of these processes;

(iii) Identify the pollution control techniques adopted at these industrial processes;

(iv) Determine the efficiency of these pollution control techniques;

and hence,

(v) Determine the 'residual' pollution emission coefficients for each of these processes.

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(1) The US EPA Study's data on the pollution coefficients for the major industrial processes in the beverage container systems are detailed in Fisher (1979).

(2) This is the same procedure followed by the Environment Directorate of OECD in their pollution control cost studies [see OECD (1977a, 1982)].

The main possible sources for this information include: the current literature on pollution [e.g., the pollution control cost studies produced by OECD [OECD (1973, 1977a, 1977b, 1982, 1983a)]; central government agencies such as the Department of the Environment (DOE) and the Central Unit on Environmental Pollution (CUEP); the industries concerned; the various bodies that are identified in the DOE's register of research [DOE (1977a, 1977b)] as undertaking research in the revlevant areas; and the reports of public enquiries [see DOE (1968, 1976)], although it should be noted that these public enquiries relate only to proposed <u>plans</u> for <u>new</u> plants which may not be representive of the actual practice of the plants currently in operation.

An additional and alternative method might be used for water pollution. This is based on the effluent charges paid by industrial firms to the Water Authorities, which could yield data on the quantity and composition of the effluent discharged by a firm.

(II) <u>Estimation of the impacts on ambient environmental quality.</u>

The pollution emissions data would then have to be converted into terms of the resulting changes in ambient environmental quality. This might be achieved by measuring the concentrations of the pollutants in the relevant area surrounding the plant. Alternatively, dispersion modelling techniques might be used.

Information should also be supplied on the meteorological and hydrological conditions at the plant and the importance of the environmental quality of the areas surrounding the plant. This latter aspect depends upon: whether these areas are used for industrial, commercial, residential or recreational purposes; the size of the human and wildlife populations likely to be affected by the pollution; the nature and seriousness of these cases; and the opinion of the pollution control authorities on the importance of this pollution. This information could be useful in assisting the selection of values that were appropriate for these conditions in the further stages III and IV. Furthermore, this information could give an indication of the significance of the pollution impacts. This would be particularly valuable for those cases where it is not possible to determine accurately specific ambient concentration levels and derive physical and monetary measures for the pollution damage.

(III) Estimation of physical measures for the environmental damages.

Dose-response relationships could be used to convert the ambient concentration levels for some pollutants into terms of physical measures, such as mortality and morbidity impacts, corrosion and crop damage. The OECD report [OECD (1983b)] gives an extensive survey of dose-response relationships.

(IV) Monetary evaluation of the environmental damages.

Some of these physical measures could be converted into monetary terms by using monetary values for these items, such as the value of human life, which are surveyed in OECD (1983b). In other cases, the results from consumer surveys could be used to evaluate such aspects as the aesthetic impacts of environmental quality changes (e.g. reduced visibility)(3).

The evaluation would be more complicated where, as frequently occurs in practice, a firm discharges its effluent to a municipal treatment plant, for which it pays a charge. According to the water authorities, these effluent charges approximately cover the treatment costs so that the financial costs of municipal treatment plants are not 'external' costs. In such cases, the external costs are represented by a portion of the total environmental damages due to the residual effluent from the treatment plant. The procedure outlined above could be used to evaluate these total damages, which would then have to be apportioned between the various polluters. This may be difficult. Alternatively, an indication of the significance of an industry's effluent could be obtained by reporting the water authorities' opinion on whether an industry's effluent or any changes in its effluent would create significant problems.

7.2.2 Practical constraints

However, the estimation of these external costs presents a number of practical problems.

First, the alternative beverage container systems cover a wide range of industrial processes and there are a large number of firms engaged in these processes.

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(3) The OECD report [OECD (1983b)] also reviews the results of recent 'bidding game' evaluations of impaired visibility.

Second, the pollution emissions from firms in the same industry can vary on account of the different production and pollution control techniques employed by the individual firms.

Third, the efficiency of the pollution controls can vary between different time periods (e.g., due to plant breakdowns and operational problems).

Fourth, the conversion of any pollution emissions into terms of the more relevant concentration levels in the environment is complicated by the numerous determining factors which include: the total quantity of pollutants emitted over a period; the manner in which these pollutants are emitted (e.g., the height of the chimney); and the local hydrological and meteorological conditions. These factors, especially the latter, can vary from place to place and over different time periods. At present, measurements of ambient concentration levels are only made for a limited number of pollutants (e.g., SO_2) on account of high monitoring costs. This limits the feasibility of obtaining data on the ambient concentration levels in the areas around the various factories. Freeman (1979a) also questions the accuracy of the estimates for ambient concentration levels derived from the present dispersion models.

Fifth, there is considerable controversy and a lack of definitive evidence on the impacts of specific pollutants on humans, plant and wild life [See OECD (1983b)]. Moreover, the impacts of a pollutant can also be altered by its interaction with other pollutants present in the environment.

The damages from the pollutants will therefore vary from place to place depending upon: what other pollutants are present in the local environment; the ambient concentration levels of these pollutants; the use to which the local environment is put; and the size of the human and wild life populations affected by the pollutants.

Consequently, in the selection of the dose-response relationships to be adopted, care would have to be exercised to ensure that they were as appropriate as possible for the particular situations under review.

Finally, there is also considerable controversy over the monetary valuations for pollution damage given by the various studies [see OECD (1983b)].

These practical constraints, along with the importance attached to the subject under review (and hence the resources that could be allocated to acquire the additional data ideally required), determine not only the depth and extent to which it is possible to follow through the stages of the methodology outlined in Section 7.2.1, but also the accuracy of the monetary evaluations that could be generated.

7.2.3 The 'best practicable' methodology applied

7.2.3(i) Data constraints

U.K. Data were not available on neither the pollution emission levels from the large number of plants involved in the U.K. beverage container systems nor the ambient concentration levels of the pollutants in the areas surrounding these plants. Similarly, information was not readily available on relevant characteristics of these areas (e.g. meteorological conditions, size of the human and wildlife populations affected by the pollution, etc. - See Section 7.2.1.).

7.2.3(ii) <u>The scope of this analysis</u>

This thesis covers the first stage of the evaluation - estimation of the residual pollution emissions of the alternative beverage container systems. Data constraints prevented the performance of the further stages outlined in Section 7.2.1. Moreover, earlier beverage container studies [e.g. OECD (1978)] had suggested that the air and water pollution impacts of the beverage containers were a relatively minor aspect of the returnable vs non-returnable container issue. This indicated that it was not worthwhile to allocate the considerable research needed to obtain the extensive and site-specific information required to perform the further stages.

7.2.3(iii) <u>Limitations of this analysis</u>

The analysis had to be based on data from two overseas studies [US EPA (1974), Basler and Hofman (1974)] since comprehensive U.K. data was not available. However, the overseas data may not be directly applicable to the specific situation in the U.K. Therefore, these limitations are identified in Section 7.4, where these overseas studies are critically appraised. The data from one of these studies [US EPA (1974)] are then adjusted to allow for the major differences between the container systems analysed in this study and the U.K. situation.

It is acknowledged that these adjusted figures are still subject to some limitations, particularly concerning their being based upon US pollution coefficients that were derived in 1974. Section 7.2.1 examined how actual data could be obtained on the pollution emissions generated by the current beverage container systems in the U.K. Appendix VI presents two case studies that were undertaken of two of the process stages in the beverage container systems. These case studies effectively highlight the practical problems of acquiring all the appropriate data required. In the light of these practical problems, the adjusted figures represent the best data that could practicably be obtained on pollution emissions from the alternative beverage container systems. These practical problems may also explain why a pollution impact study of the beverage container systems has not yet been undertaken for the U.K. and why overseas' studies are the only source of quantitative data that is currently available on this subject.

An important limitation of the pollution emissions data is that, on their own, they do not indicate the significance of the pollution damage caused by the beverage container systems. This limitation was particularly marked for the US EPA study, in which all of the specific pollutant emissions have been added together on an equal basis to give aggregate figures for the total quantity (in Kgs.) of air and water pollutants. However, this summation procedure is not entirely suitable since it does not take into account variations in the relative damage caused by the different pollutants. For example, more environmental damage is caused by 1 kg. of waterborne mercury emissions than by 1 kg. of suspended or dissolved solids. The Basler and Hofman study has attempted to convert the quantities (in kgs.) of pollutant emissions into a more relevant measure of pollution <u>damage</u> by assigning a weight of 1000 to the emissions of waterborne mercury and a weight of one to the other water pollutants (i.e., BOD, suspended solids, etc.) and by using the immission standards for each air pollutant to weight the specific air pollutant emissions according to the following formula:

$$\text{Total weighted emissions} = \frac{e_i}{mg_i/m^3}$$

where e_i = estimated emissions of pollutant i in kgs. per 1000 litres of beverage

mg_i/m^3 = permissible standard for pollutant i measured in mg. per cubic metre.

These immission standards are the target ambient concentration levels for the pollutants. It is to be expected that stricter standards are set for pollutants which cause greater environmental damage so that these standards will give a better, surrogate measure for the relative damages of the various pollutants.

Such uniform pollution standards are not specified in the U.K., where controls are exercised through the application of best practicable means in each local case. Therefore, a combination of various other countries' ambient air quality standards has been used to derive the

'EPA adjusted' figures presented in Sections 7.4 and 7.5. Quality standards for water pollutants are not so comprehensively documented. Despite an extensive literature search(4), it was not possible to determine relative standards that could be used as weights for the water pollution data. Consequently, Sections 7.4 and 7.5 just present the water pollution and also industrial solid waste data in terms of their original units (e.g. tonnes of pollutants).

Table 7.1 presents the ambient air quality standards used for the calculations in this thesis. These relative standards were derived on the basis of the standards in the Basler and Hofman study [Basler and Hofman (1974)], data given in Jarrault (1980) on the ambient air quality standards of ten countries, and discussions with experts in the Environment Directorate of the OECD.

These international standards are subject to some limitations. They may not be entirely appropriate weights for the pollution emisssions from industrial plants in the U.K. on account of differences in the factors determining the relative damage caused by specific air pollutants (e.g. local environmental conditions, type of flora and fauna in affected areas, presence of other pollutants, etc.). The standards may also give an imperfect measure of relative damages of air

(4) The literature reviewed included: Committee on Water Quality Criteria (1968, 1973), US Council on Environmental Quality (1979), Environment Agency (1979), Ministry of National Health and Welfare (1980).

Table 7.1

Ambient air quality standards used for calculating the weighted air pollution emissions

Pollutant	Standard (mg/m^3) (maximum 24 hour average)
Particulates	0.11
Nitrogen oxides	0.08
Hydrocarbons	7.9
Carbon monoxide	1.0
Sulphur oxides	0.11
Aldehydes	0.1
Other organics	0.1
Hydrogen sulphur	0.02
Ammonia	0.17
Chlorine	0.036
Fluorine compounds	0.008
Lead	0.0008
Mercury	0.0003

Source: - Basler and Hoffman (1974)
- Jarrault (1980)
- Discussions with experts in the Environment Directorate of the OECD, Paris.

pollutants to the extent that they are influenced not only by the environmental damages but also by industries' abatement costs, and where the effect of these abatement costs varies between different pollutants. However, in this respect, it should be noted that the standards in Table 7.1 are ambient air quality standards or targets rather than emission standards for specific industries, which should reduce the significance of this imperfection.

Some authors have attempted to develop more accurate indices of the damage caused by pollutants. These studies have been based on either the physical damage functions of specific pollutants [e.g., see Scottish Development Department (1976)] or a delphi-type analysis of experts' opinions [e.g., see Dee (1972), Lowe and Lewis (1981)]. However, despite the expenditure of a considerable amount of effort, the final indices were still imperfect and arbitrary. For the purposes of a study of beverage containers, it is therefore reasonable to use the ambient air quality standards shown in Table 7.1 since they represent the best surrogate measure that is currently available of the relative environmental damage caused by the various pollutants.

The use of these standards as weights produces a better measure of the alternative beverage container systems' relative air pollution damage than would be represented by the original unweighted quantities of air pollution emissions.

However, these weighted measures fail to give an indication of the significance of the overall air pollution impacts of beverage container systems. These standards have limited usefulness for the aggregation and comparison of air pollution impacts with other impacts, such as waste disposal costs. A prime benefit of monetary valuations of environmental impacts is that they facilitate such aggregations and comparisons. Therefore, ideally, a monetary evaluation should be made of the beverage container systems' pollution impacts by following through the further Stages II to IV of the methodology developed in Section 7.2.1. An alternative, qualitative and less demanding approach would be to supplement the weighted and/or unweighted pollution emissions data with information, outlined in Stage II of the 'best available' methodology developed in Section 7.2.1, on the environmental situation at the various plants involved in beverage container systems.

The large number of diverse plants involved in the alternative beverage container systems and the limited research resources available meant that it was not practicable to acquire even such qualitative information for this thesis, which had to be limited to reporting some information on the significance of the overall pollution impact of the beverage container systems.

7.3 Review of the available data

Two major studies have been undertaken of the pollution emissions of the alternative beverage container systems. One study was performed in Switzerland by Basler and Hofman (1974) and the other in the United States by the EPA [US EPA (1974)]. The results of the US EPA study are shown in Table 7.2 below. The EPA report also gave some detailed information on the specific pollutants generated by the alternative beverage container systems. A summary of this information is presented in Appendix V.

The results of the Swiss study by Basler and Hoffman (1974) are shown in Table 7.3.

The general picture that emerges from these studies is that the returnable system generates the least air pollution emissions followed by the bimetallic can and non-returnable bottle with the aluminium can system generating the most air pollution. Table 7.2 shows that, in spite of the extra washing required for returnable bottles,

Table 7.2

Air and Water Pollution Emissions per 1000 litres of beer(3) distributed in the alternative container systems

Container System	Pollution Emissions					
	AIR		WATER			
	Pollution Emissions (Kg.)	Ranking	Pollution Emissions (Kgs.)	Ranking	Volume of Waste Water Discharged (10^3 litres)	Ranking
Returnable bottle						
19-trip(1)	8.45	(1)	3.3	(1)	11.35	(1)
10-trip(1)	11.3	(2)	4.2	(3)	15.4	(3)
5-trip(1)	24.0	(3)	8.3	(6)	32.5	(4)
Non-returnable bottle	31.3	(5)	6.8	(4)	36.9	(6)
Bimetallic Can (2)	26.6	(4)	4.1	(2)	34.1	(5)
Aluminium Can	38.7	(6)	7.1	(5)	15.1	(2)

Source: US EPA (1974)

(1) The 19-trip returnable bottle relates to an 'ON' premise distribution system, while the 10 and 5-trip returnable bottles relate to 'OFF' premise systems. The supplementary packaging for these bottles is discussed in Section 7.3.2.
(2) The Bimetallic can is a 3-piece tinplate can with an aluminium top.
(3) The EPA's ranking of the pollution impacts of the alternative containers for soft drinks is very similar to those given above for beer.

Table 7.3

Air and water pollution from 3 container systems for 1000 litres of beverage

Container System	POLLUTION			
	Air pollution		Water Pollution	
	(Kgs)(1)	Ranking	(Kgs)	Ranking
Returnable bottle 20-trip	76.1	(1)	0.87	(1)
Non-returnable bottle	145.8	(3)	6.05	(2)
Bimetallic Can	126.5	(2)	14.88	(3)

Source: Basler and Hofman (1974)

(1) This Swiss study has weighted the air pollutant emissions by the immission standards for each pollutant [see section 7.2.3 (iii) of text].

the returnable system uses less water than the non-returnable bottle and bimetallic can systems. However, in terms of the more important water pollutants (BOD, suspended solids, etc.), there appears to be some discrepancy between these studies' ranking of the alternative container systems. The Swiss study shows that the returnable bottle system results in the least water pollution followed by the non-returnable bottle with the bimetallic can system generating the most water pollution; while, according to the US EPA study, the bimetallic can causes the lowest water pollution and the (5-trip) returnable bottle the most water pollution. These separate studies are now critically examined in the light of the main factors that could cause this discrepancy.

7.4 Critical appraisal of the overseas' studies

The EPA [US EPA (1974)] and Swiss [Basler and Hofman (1974)] studies were selected for the analysis in section 7.3, since they are the most comprehensive and thorough studies that are currently available on this subject. Nevertheless, they are still subject to some limitations. In particular, it should be noted that these overseas' studies may not necessarily represent the position for the U.K. These limitations arise from three factors relating to:

1. The methodology and assumptions adopted in these studies.
2. Differences between the beverage container markets in the separate countries.
3. Different production and pollution control techniques adopted in the industrial processes involved in the alternative beverage container systems in the separate countries.

As a result of these factors, it is necessary to exercise caution in interpreting the results of overseas' studies. A detailed critical appraisal of these studies in the light of factors 1-3 above is presented in Fisher (1979). In relation to the third factor, this report suggested that the production and pollution control techniques currently operated in the U.K. might well differ from those techniques that were adopted for the compilation, in 1974, of the US EPA and Swiss studies. However, only the US EPA study gave the disaggregated data required for the identification of the emission coefficients that had been used for the calculations and it was not feasible to obtain data on the appropriate coefficients for the UK to compare with these data used in the US EPA study. Consequently, it was not possible to determine the extent of any limitations of the EPA and Swiss studies on account of this factor.

In this thesis, the critical appraisal of the overseas' studies concentrates upon the most important aspects of the first two factors to give a better understanding of the important methodology and assumptions behind the overseas studies results. Some information is presented to indicate in what ways the overseas' data are not applicable to the situation in the U.K. This critical appraisal is more explicit and thorough than earlier reviews of this subject [e.g., OECD (1978), SEMA (1978)].

7.4.1 Methodology and assumptions adopted in the overseas' studies

7.4.1.1 Total systems approach

As was stated earlier, it is necessary to analyse the 'residual' pollution from all the industrial processes involved in the total beverage container system. Such a thorough and comprehensive analysis was undertaken in both the US EPA (1974) and the Basler and Hofman (1974)[5]

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(5) The US EPA (1974) and Basler and Hofman (1974) studies have included the pollution emissions from the disposal of the container in post-consumer solid waste in their estimates of the total pollution emissions from the beverage container systems, which were presented earlier in tables 7.2 and 7.3. However, pollution from waste disposal sites was one of the factors that was considered in chapter 5. Therefore, in order to maintain consistency and avoid double counting in this thesis, the pollution emissions relating to the disposal of the container have not been included in the derivation of the adjusted figures for the US EPA study and in the calculation of the levels of pollution emissions under the scenarios I-IX.

studies. The Basler and Hofman study also included the pollution from the consumers' transport to and from the retail outlets, on the basis of 5 km. being travelled for each 24 containers purchased. This was a significant portion of the total air pollution figures in this study. The US EPA study did not include consumers' transport on the (probably justifiable) grounds that the consumer's trip is already necessary for other purposes, such as the purchase of food and other goods.

7.4.1.2 Scope of the studies

The US EPA study investigated 13 specific categories of air pollutants and 14 categories of water pollutants, while the Swiss study covered 10 and 3 categories of air and water pollutants, respectively. The US EPA study also estimated the level of industrial solid wastes generated by the alternative beverage container systems and the results are presented in table 7.4. The generation of solid waste was most significant for the mining of iron ore and the refining of the Alumina for the bimetallic and aluminium cans, so that these can systems generated the highest quantity of industrial solid waste. According to the US EPA report, the other main sources of industrial solid waste were: the mining of the large quantities of coal required to make the steel for the bimetallic can; and the mining of feldspar and the manufacture of soda ash for the glass bottles.

Table 7.4

Industrial solid waste generation from the distribution of 1000 litres of beer by the alternative container systems

Container System	Industrial Solid Waste	
	m^3	Ranking
Returnable bottle - 19-trip(1)	0.05	(1)
- 10-trip(1)	0.07	(2)
- 5-trip(1)	0.11	(3)
Non-returnable bottle	0.25	(4)
Bimetallic Can	0.7	(6)
Aluminium Can	0.27	(5)

Source: US EPA (1974)

(1) See Note (1) Table 7.2.

7.4.2 The structure of the beverage industry

7.4.2.1 Pollution emissions from container-related processes

7.4.2.1(i) The weight of the containers analysed

Tables V.3-V.5 in Appendix V show that pollution emissions from the processes related to the actual container (i.e., the extraction and processing of the energy and raw materials and their manufacture into containers) make up a large proportion of the total pollution emissions from the non-returnable systems, especially the bimetallic and aluminium cans for which these container-related processes account for 91 to 95 per cent of their total air and water pollution emissions. Therefore, the pollution levels of the alternative container systems could be significantly affected by the weight of the individual beverage containers.

Table 7.5 gives data on the weight of the beverage containers analysed in the US EPA and Swiss studies. This table also includes some information on the weights of

Table 7.5

The size and weight of the beer[1] containers analysed in the Swiss (Basler and Hoffman) and US EPA studies.

Beverage container	Size	Weight (grams)		
		EPA	Swiss[1]	U.K.[2]
Returnable bottle (RB)	12 oz.	277	-	300[3]
" "	1 litre	-	800	675[4]
Non-returnable bottle (NRB)	12 oz.	186	-	235
" "	litre	-	500	600
3-piece Bimetallic Can	12 oz.	50	-	42[5]
" " "	1 litre	-	140	-
" " "	2.27 litres	-	-	245[6]
2-piece Aluminium Can	12 oz.	20	-	18[7]

Source: US EPA (1974), Basler and Hofman (1974), Metal Box Market Research Division.

(1) It is not certain whether the Swiss (Basler and Hofman) study analysed beer or soft drinks containers. Soft Drinks bottles are generally heavier than beer bottles.

(2) The last column gives some information on the weights of equivalent beverage containers in the UK market. In some cases, beer containers of the same size as those analysed in the overseas' studies are not used in the U.K. In these cases, the weight of the closest equivalent container in the U.K. market is shown.

(3) This refers to a 10 oz. returnable beer bottle. The weight of a 20 oz. returnable beer bottle is 470 grams. It is estimated that a 12 oz. returnable beer bottle would weigh about 350 grams.

(4) This refers to a 40 oz. returnable beer bottle.

(5) This refers to a 12 oz. soft drink can. The weight of a 10 oz. beer can is 41 grams. The weight of a 16 oz. beer can is 55 grams.

(6) This refers to a 4-pint 'party' can.

(7) This refers to a 10 oz. aluminium beer can. The weight of a 16 oz. aluminium beer can is 23 grams.

equivalent containers in the current U.K. beverage market. This indicates that the U.K. glass bottles are slightly heavier and the bimetallic cans slightly lighter than those analysed in the US EPA study, while the Swiss study analysed returnable bottles that were heavier and non-returnable bottles that were lighter than the equivalent UK bottles.

7.4.2.2 Breakeven trippages for the returnable system in the US EPA study

However, for the returnable system, the pollution from the processes related to the bottle will be amortised by the number of trips made by the bottle. Therefore, it is important to make the distinction between the trippage dependent process stages for which the pollution emissions will vary directly with the bottle's trippage, and the trippage independent process stages that occur irrespective of whether a new or a returned bottle is used. This distinction enables the calculation of the important breakeven trippages that the returnable bottle has to achieve to generate less air and water pollution than the non-returnable systems. Of the two available studies, only the US EPA report gave the disaggregated data required to enable this distinction to be made (see Tables 7.6 and 7.7). Therefore, it has only been possible to use the data in US EPA study to calculate the breakeven trippages shown in Table 7.8.

However, it must be noted that these breakeven trippages relate to a particular distribution system and that therefore they must be viewed in the light of the specific features of the beverage container systems studied in the US EPA report.

Table 7.6

Trippage dependent pollution emissions per 1000 litres of beer for a returnable bottle system (with a trippage of one)

Process Stage(1)(2)	Air Pollution emissions (Kgs.)	Water Pollution emissions (Kgs.)	Industrial Solid Waste (m^3)
RM extraction and processing	10.0	0.9	0.056
MFR of bottle	14.8	1.35	0.005
Total	24.8	2.25	0.061

Source: US EPA (1974)

(1) The figures above include the pollution emissions from the actual processes and also the pollution associated with the energy required at the process.
(2) This table does not include the pollution emissions from the disposal of the containers in post-consumer solid waste since the pollution from waste disposal sites was considered in chapter 5 [see footnote (5), page 307].

7.4.2.3 Specific features of the beverage container systems in the US EPA study

7.4.2.3(i) Distribution distances

The beverage market in the USA is more dispersed on account of the greater population density in the U.K. Therefore, distribution distances should be lower for the U.K. The pollution emissions associated with the distribution of returnables are higher than the pollution emissions from the distribution of non-returnables. Therefore, allowing for this imperfection of the US EPA study should lead to a greater reduction in pollution emission levels for the returnable system.

Table 7.7

Trippage independent pollution emissions per 1000 litres of beer for the returnable bottle systems

Process Stage(5)	Air Pollution (kgs) Returnable System(3)			Water Pollution (kgs) Returnable System(3)			Industrial Solid Waste (m^3) Returnable System(3)		
	5-trip	10-trip	19-trip	5-trip	10-trip	19-trip	5-trip	10-trip	19-trip
Packaging(2)	14.88	4.97	3.6	5.89	1.97	1.24	0.022	0.008	0.005
Closure	0.46	0.46	0.46	0.06	0.06	0.06	0.025	0.025	0.025
Filling	1.37	1.37	1.37	1.73	1.73	1.73	0.004	0.004	0.004
Transport(4)	1.88	1.74	1.59	0.16	0.15	0.13	-	-	-
TOTAL	18.59	8.54	7.02	7.84	3.91	3.16	0.051	0.037	0.034

Source: US EPA (1974)

(1) See Note (1) Table 7.6
(2) This includes the pollution resulting from the extraction and processing of the wood pulp as well as the manufacture of the paper packaging.
(3) The three returnable bottle systems require different quantities of supplementary paper packaging (see text).
(4) The category transport includes the transportation involved in the extraction, processing, manufacture and distribution of the supplementary packaging and closures as well as the distribution of the filled and empty beverage containers.
(5) See Note (2) table 7.6

Table 7.8

Breakeven trippages for the three returnable systems to generate less air and water pollution and industrial solid waste than the non-returnable container systems[2]

Non-returnable Container System	Air Pollution			Water Pollution			Industrial Solid Waste		
	Returnable System[1]			Returnable System[1]			Returnable System[1]		
	5-trip High S-Pack	10-trip	19-trip Low S-Pack	5-trip High S-Pack	10-trip	19-trip Low S-Pack	5-trip High S-Pack	10-trip	19-trip Low S-Pack
Non-returnable Bottle	2.1	1.1	1.1	∞[3]	0.8	0.6	0.3	0.3	0.3
Bimetallic Can	3.1	1.4	1.3	∞[3]	11.0	2.4	0.1	0.1	0.1
Aluminium Can	1.2	0.8	0.8	∞[3]	0.7	0.6	0.3	0.3	0.3

Source: Derived from Tables 7.1, 7.5 and 7.6.

(1) These three returnable systems require different quantities of supplementary packaging (S-Pack). The 5-trip system requires more than four times as much supplementary packaging as the 19-trip system.

(2) See Note (2) table 7.6. The pollution emissions from the disposal of the non-returnable containers in post-consumer solid waste have also not been included in the figures used for the calculation of the above breakeven trippages.

(3) The breakeven trippages of the 5-trip returnable system for water pollution are infinite (∞) since the water pollution emissions from the trippage independent processes of the 5-trip returnable system exceed the total water pollution emissions from the non-returnable systems.

7.4.2.3(ii) Supplementary packaging used

The supplementary packaging accounts for a large proportion of the pollution load from the returnable system. Table V.7 of Appendix V shows that the supplementary packaging accounts for 71 per cent of the total water pollution emissions from the 5-trip returnable bottle system analysed in the US EPA study. This study assumed that the glass bottles are packed in corrugated containers for delivery from glass manufacturer to bottling plant and that these corrugated containers are then used for the distribution of filled bottles to the retailers, for which purpose they last approximately three trips. In addition, a six-pack carrier was required for 'off' premise sale of returnable bottles to the consumer in the 5-trip and 10-trip returnable systems examined in this study. This paper carrier was assumed to achieve three trips in the 10-trip returnable system, but only one trip in the 5-trip returnable system. This is the principal cause of the higher level of total pollution emissions from this 5-trip returnable system.

However, in the U.K., glass bottles are usually packed in shrink wrap plastic on a paperboard base for delivery from the glass manufacturer to the bottling plant. Non-returnable bottles are usually packaged in paperboard carriers or in cluster packs of plastic film for their distribution to the retail outlet, while returnable bottles are distributed in returnable plastic crates which achieve a high trippage. Therefore, in the U.K., the supplementary packaging for beverage bottles, especially returnable bottles, is very much lower than the quantities analysed in the US EPA study, which consequently gives overestimates of the pollution emissions from the returnable and non-returnable glass bottle systems for the U.K.[6].

7.4.2.3(iii) Beverage filling

The US EPA assumed that the caustic wastes from the bottle-washing process are used to neutralise the acidic brewery wastes. However, apparently this is not the customary practice in this country and information from two U.K. brewers and bottlers revealed that the washing of the bottles results in some small discharges of highly alkaline (ph 12.8) effluent. For soft drink filling, US EPA assumed that the caustic effluent from bottle washing are not used to neutralise any acidic wastes from the production process and they estimated that about 1.1 Kg. of alkaline water pollutants would be discharged from the washing of the bottles for 1000 litres of soft drinks.

7.4.3 The derivation of adjusted pollution emission estimates for the U.K. from the US EPA study

The preceeding critical appraisal has highlighted a number of important differences between the beverage container systems studied by the US EPA and the current position in the U.K. Accordingly, the following adjustments have been made to the US EPA data in deriving the 'adjusted US EPA' figures presented in Tables 7.9-7.11:

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(6) The plastic supplementary packaging for the can systems analysed in the US EPA study was similar to that adopted in the U.K.

(i) Differences in the weight of the containers:
   - individual returnable and non-returnable beer bottles in the U.K. are about 26 per cent heavier than those analysed in the US EPA study;
   - the bimetallic beer can in the U.K. is about 12 per cent lighter than the can analysed in the US EPA study;

(ii) The distribution distances are lower in the U.K. than in the U.S.

(iii) Supplementary packaging used. In the U.K., the glass bottles systems, especially the returnable bottles, require considerably less supplementary paper packaging than the systems investigated in the US EPA study.

(iv) Filling. The US EPA's assumption, that the caustic wastes from the bottle washing process are used to neutralise acidic brewery wastes, does not appear to conform with the customary practice in the U.K. brewing industry. Therefore, the US EPA report's figures for the quantities of alkaline water pollutants from the soft drinks system have been included in deriving the 'adjusted US EPA' figures for the washing and filling of beer bottles.

The ambient air quality standards, shown in Table 7.1, have been used to weight the emissions of different air pollutants.

In Table 7.10, the estimated pollution emissions from the returnable system are split between the emissions from the trippage dependent and trippage independent processes. These data have then been used to calculate the breakeven trippages presented in Table 7.11.

Table 7.9

Air and water pollution and industrial solid waste generated per 1000 litres of beer distributed in the alternative container systems - 'adjusted US EPA' figures(2).

Container System	Air Pollution Weighted Damage(1)	Air Pollution Ranking	Water Pollution (Kgs.)	Water Pollution Ranking	Industrial Solid Waste (m^3)	Industrial Solid Waste Ranking
Returnable Bottle T(3) = 20	49.6	(1)	3.62	(1)	0.05	(1)
T = 10	61.2	(2)	3.76	(3)	0.07	(2)
T = 5	84.6	(3)	4.04	(5)	0.108	(3)
Non-returnable bottle	230.4	(5)	3.87	(4)	0.292	(5)
Bimetallic Can	180.5	(4)	3.67	(2)	0.613	(6)
Aluminium Can	279.9	(6)	7.06	(6)	0.271	(4)

Source: Data in US EPA (1974)

(1) The air pollutant emissions have been weighted by the ambient air quality standards for each pollutant according to the following formula:

$$\text{Weighted emissions} = \frac{e_i}{mg_i/m^3}$$

where e_i = estimated emissions of pollutant i, in Kgs. per 1000 litres of beer distributed

mg_i/m^3 = ambient air quality standard for pollutant, i, in mgs. per cubic metre.

(2) This table does not include pollution emissions from the disposal of the containers in post-consumer solid waste since the pollution from waste disposal sites was considered earlier in chapter 5 [see footnote (5) page 307].

(3) T = trippage

Table 7.10

The air and water pollution and industrial solid waste generated from the trippage dependent and trippage independent processes of the returnable system for the distribution of beer ('Adjusted EPA' figures)

Process(2)	Air Pollution (Weighted damage)(1)	Water Pollution emissions (kgs.)	Industrial Solid waste (m^3)
Trippage dependent (for a trippage of one)	233.7	2.82	0.385
Trippage independent	37.9	3.48	0.031

Source: As in Table 7.9

(1) See Note (1) Table 7.9
(2) See Note (2) Table 7.9

Table 7.11

Breakeven trippages for the returnable bottle system to generate less air pollution, water pollution and industrial solid waste than the non-returnable container systems ('Adjusted EPA' figures)

Non-returnable Container	Air Pollution	Water Pollution	Industrial Solid Waste
Non-returnable bottle	1.2	7.2	1.5
Bimetallic Can	1.6	14.8	0.7
Aluminium Can	1.0	0.8	1.6

Source: Tables 7.9 and 7.10

7.5 The levels of the beverage container systems' pollution emissions under the scenarios I-IX

The (unweighted) 'adjusted EPA' figures have been used to estimate that the container systems for 'off' premise sales of carbonated beverages in the U.K., in 1977, generated about 43,090 tonnes of air pollutants, 8,570 tonnes of water pollutants and about 731,000 cubic metres of industrial solid waste. The National Society for Clean Air estimates that the total quantity of just one pollutant (sulphur oxides) emitted in the U.K. in 1973 was 6.42 million tonnes [National Society for Clean Air (1976)]. This gives some idea of the low order of magnitude of the beverage containers' contribution of the overall national level of all pollutants. Other studies have also suggested that pollution emissions from beverage container systems do not represent a significant portion of total national pollution [see Statens Offentliga Utredningar (1976), OECD (1978)]. This is an additional reason why no attempt has yet been made to undertake a full pollution impact study of the U.K. beverage container systems. Moreover, it gives further support for using the best practicable figures from the 'adjusted EPA' figures, rather than deriving actual U.K. data to calculate the level of pollution emissions under the different scenarios for 1977 and 1982.

Estimates for the total pollution levels from the beverage container systems under scenarios I-IX are given in Table 7.12. Table 7.13 highlights the major features of the different scenarios.

Table 7.12 shows that pollution emissions from the container systems for the 'off' premise sales of carbonated beverage in the U.K. are estimated to increase by 32-43 per cent over the period 1977 and 1982. This is due to the predicted increase in the use of non-returnable bottles and aluminium and bimetallic cans for beverages and due to the decline in the returnable's trippage. However, it should be noted that these figures in Table 7.12 do not allow for any reductions in container weights and pollution coefficients arising from technological improvements over this period so that the data in table 7.12 gives an overestimate for the increase in pollution levels.

Table 7.12 shows that the extrapolation of the trends of an increasing use of non-returnables to the extreme case of the 100 per cent non-returnable system, depicted in scenario III, would result in an increase in air pollution and quantities of industrial solid waste. However, the level of water pollution emissions from the beverage container systems is lower under scenario III than under the 1982 baseline scenario II. This is due to the low level of 3 to which the returnable bottle's trippage is currently forecast to decline by 1982. For similar reasons, the level of water pollution emissions is higher under scenario VI, which depicts an intermediate increase in the returnable's market share but with the trippage rate remaining at this low level of 3.

Table 7.12 The quantities of air and water pollution and industrial solid waste generated by the container systems(2) for 'off' premise carbonated beverage sales in the U.K. under scenarios I-IX.

Scenario	Air Pollution Weighted Damage(1)			Water Pollution			Industrial Solid Waste		
		Δ vs Scenario II(3)			Δ vs Scenario II(3)			Δ vs Scenario II(3)	
	10^6 units p.a.	10^6 units p.a.	%	000s tonnes p.a.	000s tonnes p.a.	%	000s m^3 p.a.	000s m^3 p.a.	%
I - 1977	339	-(3)	-	8.6	-	-	731	-(3)	-
II - 1982 - No Action	483	+144(3)	+43.0%(3)	11.3	+2.8(3)	+32.0%(3)	997	+266(3)	+36.0%(3)
III - 1982 - 100% NRF	563	+80	+17.0%	11.0	-0.3	-3.0%	1120	+123	+12.0%
IV - 1982 - 1977 market shares T = 4	439	-44	-9.0%	11.2	-0.2	-2.0%	893	-104	-10.0%
V - 1982 - RB↑ T = 6	356	-127	-26.0%	10.7	-0.6	-5.0%	679	-318	-32.0%
VI - 1982 - RB↑ T = 3	413	-70	-14.0%	11.4	+0.1	+1.0%	773	-225	-23.0%
VII - 1982 - mandatory deposits	295	-188	-39.0%	10.5	-0.8	-7.0%	617	-381	-38.0%
VIII - 1982 - 100% RB T = 10	160	-323	-67.0%	9.8	-1.5	-13.0%	182	-816	-82.0%
IX - 1982 - 100% RB T = 15	140	-342	-71.0%	9.6	-1.8	-16.0%	148	-849	-85.0%

Source: Tables 7.9 and 7.10

(1) See Note (1) Table 7.9
(2) See Note (2) Table 7.9
(3) The figures in these columns show the differences between the results of scenarios III-IX in comparison with the baseline scenario II for 1982 . However, for scenario II the figures refer to the difference between this forecast scenario II for 1982 and the situation in 1977 under scenario I.
(4) Where NRF = non-returnable bottles and cans
RB = returnable bottle
T = trippage

Table 7.13 Principal features of the scenarios analysed

	SCENARIO	'OFF' Premise sales of beer, cider and carbonated soft drinks in returnable and non-returnable containers in millions of litres and as a % of total packaged 'off' premise sales						'OFF' Premise Trippage
		Non-returnable Glass bottle		Non-returnable Metal Can		Returnable Bottle		
		Vol.	(% of Σ)	Vol.	(% of Σ)	Vol.	(% of Σ)	
I	1977 SITUATION	348	(17%)	935	(45%)	800	(38%)	4
II	NO ACTION Forecasts for 1982	511	(20%)	1375	(52%)	730	(28%)	3
III	100% Non-returnable system	1129	(43%)	1487	(57%)	0	(0%)	not applicable
IV	Market share and trippage achieved by the returnable bottle in 1977[(1)]	418	(16%)	1214	(46%)	984	(38%)	4
V	Returnables' market share X 2 higher trippage X 2	313	(12%)	843	(32%)	1460	(56%)	6
VI	Returnables' market share X 2 Lower Trippage	313	(12%)	843	(32%)	1460	(56%)	3
VII	FOE post-mandatory Deposit situation	0	(0%)	943	(36%)	1673	(64%)	10
VIII	100% Returnable system	0	(0%)	0	(0%)	2616	(100%)	10
IX	100% Returnable system Higher trippage	0	(0%)	0	(0%)	2616	(100%)	15

(1) The market shares in 1977 between the different containers for each beverage (i.e., beer, cider and carbonated soft drinks) have been used in scenario IV for 1982. However, the aggregate market shares shown above for scenario IV are not exactly the same as the aggregate market shares in 1977 on account of differences in the sales growth rates between 1977 and 1982 for the different beverages.

The importance of achieving increases in the returnable's trippage can also be seen by comparing the greater reductions in pollution levels under the higher trippage intermediate scenario V with the results for the intermediate scenario VI where trippage fails to increase. The results for scenarios VII, VIII and IX further highlight the reductions in pollution emissions that could be achieved by increases in the returnable bottle's market share and trippage.

7.6 Conclusions

Section 7.2 of this chapter outlines a methodology for evaluating the external costs of the pollution generated by the beverage container systems. This methodology consists of the following four sequential stages : Calculation of the residual pollution emissions from the beverage container systems; their conversion into terms of the ambient concentration levels of the pollutants in the areas surrounding the various plants; estimation of physical measures for the resulting damages; and monetary evaluation of these environmental damages.

Data constraints meant that it was only possible to perform the first stage in this thesis. Moreover, lack of U.K. data meant that the calculations had to be based upon overseas data.

It had been argued that these overseas studies are not applicable to the particular position in the U.K. Therefore, these overseas' studies are critically analysed in section 7.4, which highlights a number of important shortcomings of these studies. In particular, section 7.4 demonstrates that the supplementary paper packaging for the returnable bottles analysed in the US EPA study is significantly greater than that currently used in the U.K. Consequently, the figures in the US EPA study have been adjusted to allow for some important differences between the US EPA study and the current U.K. situation.

A combination of the results of the Swiss study and the adjusted figures from the US EPA study indicate that the returnable bottle creates the least air and water pollution followed by the bimetallic can and non-returnable bottle with the aluminium can system generating the most air and water pollution. In addition, the 'US EPA adjusted' figures show that the returnable system generates the least industrial solid waste followed by the aluminium can and non-returnable bottle, with the bimetallic can system generating the highest level of industrial solid wastes.

However, this favourable ranking of the returnable bottle depends essentially upon the trippage achieved by the returnable bottle. It is estimated that, in order to generate less air pollution than the non-returnable glass bottle, bimetallic can and aluminium can systems, the returnable bottle has to achieve breakeven trippages of 1.2, 1.6 and 1, respectively. The breakeven trippages for the returnable system to generate less water pollution emissions than the non-returnable glass bottle, bimetallic and aluminium can systems are estimated to be 7.2, 14.8 and 0.8, respectively. In order to generate less industrial solid waste than these three non-returnable systems, the returnable bottle has to achieve breakeven trippages of 1.5, 0.7 and 1.6, respectively.

Section 7.5 highlights the reductions in the pollution emissions from the beverage container systems that could result from increases in the market share and trippage of the returnable bottle.

An important limitation of the two available overseas studies is that they do not address the question of the significance of the pollution damages caused by beverage container systems. The US EPA study is particularly deficient in this respect since the quantities (in Kgs) of the different pollutants have just been added together on an equal basis to give aggregated results in this study. In the Swiss study, the different air pollutants have been weighted by their respective ambient air quality standards. This procedure has also been adopted for the derivation of the 'adjusted EPA' figures for air pollution. This gives a slightly better indicator of the relative impacts of the alternative container systems for this single item. However, both the weighted figures and the simple aggregates are, on their own, of limited usefulness for the comparison of these pollution impacts with other economic and environmental impacts of beverage container policies.

In order to overcome this limitation, monetary valuations should ideally be derived through the performance of the further stages II - IV of the methodology outlined in Section 7.2. However, this would present a number of practical problems. Moreover, the currently available information indicates that the pollution from the beverage container systems does not represent a significant portion of total national pollution. Therefore, it would probably not be worthwhile to undertake the extensive, original research required to complete the further Stages II - IV and derive an accurate economic valuation for these pollution impacts. An alternative, less demanding approach would be to supplement the weighted and/or unweighted pollution emissions with additional qualitative information on the environmental situation at the major plants involved in the beverage container systems. This information could include: the local meteorological and hyrological conditions; the human and the (various types of) wildlife populations likely to be affected by the pollution; the nature and seriousness of these impacts; and the pollution control authorities' opinions on the importance of the pollution from the various factories. Nevertheless, on account of the many diverse industrial plants involved in the beverage container systems, even this simplified procedure would still entail extensive investigations and would constitute a difficult and costly exercise.

CHAPTER 8

PUBLIC HEALTH AND HYGIENE

Introduction

Concern has been expressed that the use of returnable bottles could present potential hygiene problems on account of the presence of any contaminants in the bottled beverage and as a result of the storage of the returned empties at the retail outlets. [Shelley (1978) Multiple Food and Drink Retailers Association (MFDRA) (1978)]. Therefore, this chapter examines these two aspects.

- Section 8.1 outlines a methodology for evaluating the external hygiene impacts of beverage containers.
- Section 8.2 assesses the incidence, nature and significance of the presence of any contaminants in the bottled beverage.
- Section 8.3 assesses the impacts resulting from the storage of the returned bottles at the retail outlets.

8.1 Methodologies for evaluating the hygiene impacts of carbonated beverage containers.

The 'best available' methodology proposed here consists of the following three sequential stages.

The first stage entails identification of the potential public health and hygiene problems that could occur. Account is then taken of the measures performed by the beverage industry to tackle these problems. An estimate is thereby given for the incidence of the residual cases of contaminants actually appearing in packaged beverages and of sanitation problems arising at the retail outlets. It is the damage caused by these residual cases that represent the external cost of these two aspects.

The second stage comprises identification of the nature and significance of these residual impacts. This is based primarily upon a review of the opinions of the regulatory agencies on this matter, although this is supplemented by any available ball park 'guesstimates' of the authorities' control costs attributable to beverage containers.

If this review found that beverage containers were creating siginificant hygiene problems, then the third stage would be performed. This would comprise a more detailed investigation of these problems: The physical incidence of the residual cases occurring would be determined more accurately and an economic evaluation would be made of these impacts. Consumer Surveys could be used for this. For example, consumers could be asked for the number of free bottles they would accept in compensation for the probability of a certain type of contaminant occuring in a beverage container. This latter figure would be obtained from the physical incidence estimates generated by the first two stages of the analysis.

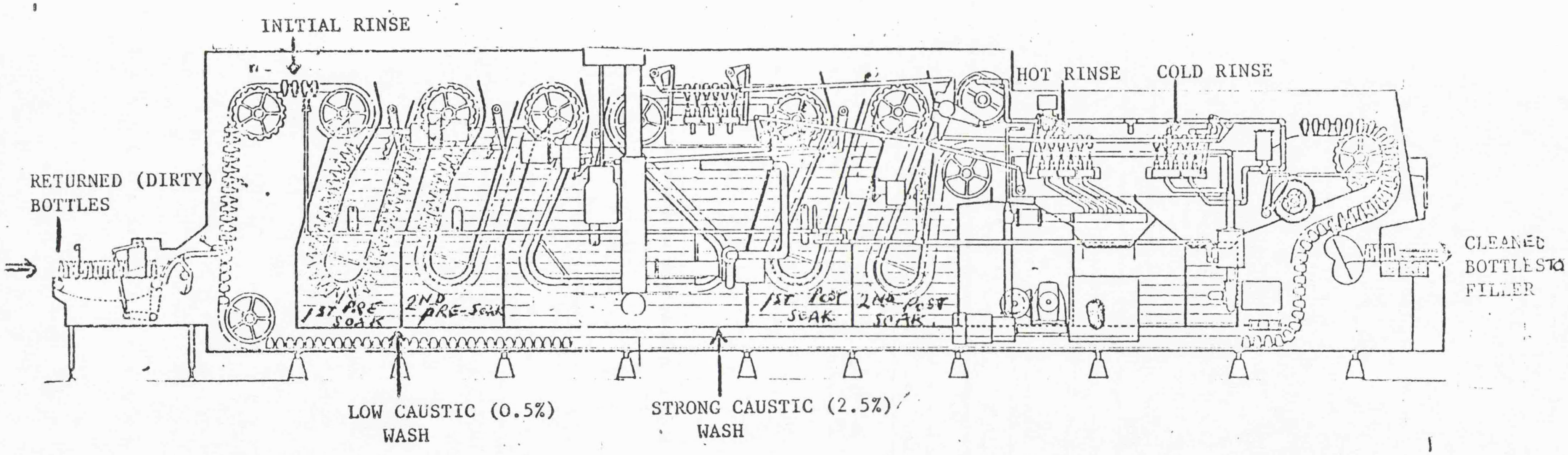
The research for the first two stages suggested that the hygiene impacts of carbonated beverage containers were of limited significance. As a result of this finding and the data collection problems involved in performing a detailed economic evaluation, the 'best practicable' methodology adopted in the thesis for the evaluation of these aspects comprises just the first two of the sequential stages outlined above.

8.2. The presence of contaminants in beverage containers

8.2.1 The incidence of cases of contaminants in beverage containers

Some of the bottles returned to bottlers contain residues of beer and soft drinks. These contaminants include dirt, flies, and crisp packets and apparently most beer bottles have beer mould in them. The presence of any contaminants in the bottled beverage would adversely affect the public image and sales of the brewer or bottler concerned and would contravene the 1955 Food and Drugs Act. Therefore, soft drinks bottlers and brewers have implemented measures to tackle this problem. At the bottling plant, the returned bottles are subject to a rigorous cleaning procedure, such as that illustrated in Figure 8.1, in which the bottles are given an initial rinse with hot water and washed first in a low (0.5%) caustic solution and then in a strong caustic solution (2.5%). Finally, the bottles are thoroughly rinsed with hot and then cold water. If a batch of returned bottles is particularly dirty, then they are sent through the washer twice. After emerging from the washing process, the bottles are inspected either visually or by an automatic optical sensor before they go on to be filled. This cleaning procedure appears to sterilise effectively the bottles and remove the contaminants.

Figure 8.1 : Illustration of the Bottle Washing Equipment used by one Brewer



One brewer reported that, during 1977, he received three complaints concerning the presence in his returnable bottles of contaminants (in each case mould)[1]. The annual bottling output of this brewery was 35 million bottles so that this represents one complaint occurring in more than 11 million bottles filled. Enquiries with five other brewers and soft drink bottlers revealed a similarly low incidence of complaints about the presence of contaminants in the bottled beverage.

Further information and data were obtained from the Environmental Health Officers Association and from three local environmental health departments[2]. One local environmental health department had received four complaints concerning beer and carbonated soft drinks in a one-year period; another had received seven or eight complaints over the last ten years; and the third department had received

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(1) This information on the practice and experiences of bottlers was obtained from interviews with six local and national bottlers and brewers. Appendix VII gives details of the areas where information was sought on this subject. This list was sent to the bottlers prior to the interview and further elaboration was obtained on these points in the course of the interviews.

(2) These three local environmental health departments (at Leicester, Leeds and Hillingdon) were selected following correspondence with the Environmental Health Officers Association and a meeting with officials at the Department of Health and Social Security (DHSS). The officials suggested that these three Environmental Health Departments would be the most likely to provide the data required for this project. These local Environmental Health Departments were then sent a questionnaire (see Appendix VIII) of the specific areas on which information was sought. A draft of this chapter was sent to these local environmental health departments and to officials at the Environmental Health Officers Association and at the DHSS. They agreed with the presented findings of the research.

seven complaints during the period 1975-1978. Most of the complaints concerned bottles. It was not possible for these departments to certify whether the data referred to returnable or non-returnable bottles, but it is to be expected that the contaminants are more likely to occur in returnable containers. However, there was one complaint concerning a piece of cardboard that was found in a beer can which indicates that some contaminants can also appear in non-returnable containers. Moreover, the problem of mould developing in beverage bottles as a result of an imperfect closure can arise for non-returnable as well as returnable bottles.

8.2.2. <u>The nature and significance of these cases</u>

The most common cause of these complaints was the presence of mould which occurred in four out of fourteen instances. There were two complaints about chips on the top of the bottle and two about the taste of the beverage. The remaining complaints concerned the presence in the beverage of a variety of foreign substances which included a fly, a straw and a plastic flower. As a result of these complaints, a warning letter was sent to the bottlers. However, it was the opinion of the Environmental Health Officers (EHOs) concerned that these instances did not constitute a health hazard and no prosecutions were made.

These complaints concerning beer and soft drinks containers represent a small proportion (between 0.03 and 0.4 percent) of the total cases of food contamination dealt with by the Environmental Health Departments. The EHOs are more concerned about the presence of contaminants in products such as bread, confectionery, meat products and milk. In this respect, it should be noted that, in contrast to the alkalinity of milk, the acidity of soft drinks and beer ($ph \simeq 4$) inhibits the development of bacteriological contamination in these beverages.

It is difficult to determine with any accuracy the costs incurred by Environmental Health Departments for the investigation of a complaint about a contaminant in a carbonated beverage container. The best 'guesstimate' that could be derived on this matter comes from one Environmental Health Department which estimated that, in 1978, a typical investigation concerning a dirty milk bottle cost in the region of £46-£50 (1978 prices)(3). This figure includes the costs of professional and administrative services performed during the investigation, but does not include the costs of any court proceedings. However, as was noted above, no prosecutions were made by the Environmental Health Departments following the reported complaints about carbonated beverage containers. Therefore, this omission is reasonable for the purposes of this study.

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(3) This estimate has two (counteracting) limitations. This particular Environmental Health Department said that its investigation procedures were very efficient and that the costs of investigations might be higher for Environmental Health Departments in other regions. However, investigations into milk bottle complaints would probably be more rigorous than investigations into complaints about carbonated beverage containers which consequently could be expected to be less costly.

This cost estimate can be applied to the earlier figure for the incidence of complaints to give a very rough estimate of the unit external control costs incurred by public authorities as a result of the presence of any contaminants in carbonated beverage containers. If it is assumed that all of the three complaints reported by the brewer mentioned earlier were investigated by the Environmental Health Department, then one investigation occurred for every 11 million returnable bottles filled. This makes the external costs of investigating complaints about the presence of a contaminant in a returnable bottle of the order of 0.0004p. per bottle filled. This means that the total national figure for the external costs of investigating all complaints relating to the 'off' premise sales of beer, cider and carbonated soft drinks in returnable bottles would be about £4,500 in 1977 (in 1977 prices). The assumptions behind this calculation probably make it an overestimate. Notwithstanding these assumptions and their limitations, this does give an indication of the low order of magnitude of the external costs resulting from investigations into complaints about contaminants in returnable bottles. As was noted earlier, the Environmental Health Departments do also investigate complaints about contaminants in non-returnable containers. Therefore, the external costs of these investigations should similarly be attributed to the non-returnable containers. However, on a per non-returnable bottle or can basis, these external costs would probably be even lower than the 0.0004p estimate derived above for the returnable bottle.

On account of the lack of hard data regarding the unit external hygiene costs of carbonated beverage containers, especially for non-returnables, it has not been possible to derive any accurate quantitative figures for the total external hygiene costs of investigating complaints concerning any contaminants in the containers used for the 'off' premise sales of carbonated beverages in 1977 and under the various scenarios for 1982. Nevertheless, the qualitative information and ball park 'guesstimates', presented above, indicate that the impacts of the residual contaminants in beverage containers are not significant. Consequently, a more detailed economic evaluation of these impacts was not undertaken.

8.2.3 Conclusion

The available data indicate that a complaint about a contaminant in a beer or soft drink bottle occurs once for about every 11 million returnable bottles filled. It is very difficult to determine an accurate estimate for the external costs of the public investigation of these complaints. Nevertheless, some very tentative calculations suggest that the unit external costs of such investigations would be less than 0.0004 pence per returnable bottle filled. It is noted that the Environmental Health Departments also investigate complaints about the presence of contaminants in non-returnable containers. The unit external costs of such investigations concerning non-returnables could be expected to be lower than the estimate given above for returnables. It is the opinion of the Environmental Health Officers that the contaminants that are found in beer and soft drinks bottles and cans do not constitute a hazard to human health. Therefore, the presence of contaminants in returnable bottles is not considered to present a significant public health problem and would not be expected to present a significant problem if there was any increase in the market share and use of returnable bottles, such as that depicted under the scenarios IV to IX for 1982.

8.3 Sanitation problems from the storage of the returned empties at the retail outlets

8.3.1. The incidence of sanitation problems at the retail outlets.

Many bottles contain residues of beer or soft drinks which could attract flies and vermin and could present potential sanitation problems while the bottles are being stored at the retail outlets. The size of these potential sanitation problems will depend upon: the proportion of screw top bottles that are returned with their tops on; the methods used by the retailers for storing the empty returnables; and the frequency with which the empties are collected.

(a) The proportion of screw top bottles that are returned with their tops on

If the screw top bottles are returned with their tops on, then residues inside these bottles will not attract flies and this will reduce the sanitation problems at the retail outlet. Consequently, some retailers ask their customers to return these bottles with their tops on. The retailers' survey, which was undertaken as part of the trippage study (see Chapter 10), revealed that four retailers, out of the 58 surveyed, stipulated that they would not accept a returnable bottle which did not have its screw top on. The three soft drink bottlers interviewed reported that almost all of their bottles were returned with the tops on[(4)]. However, the MFDRA considered that a significant proportion are returned without their tops. A crown cork closure is used for many returnable bottles (e.g., beer bottles) which would be returned without tops.

(b) <u>Storage methods</u>

The retailers recognise the potential problems presented by returned beverage containers and take into account these and a number of other possible food contamination problems when organising their storage arrangements. Thus, the retailers attempt to keep separate the main food stocks from the returned empties, which they endeavour to place in a separate section or in an outside shed or storage area. The actual storage arrangements used by the retailers vary depending upon the type of retail outlet, its location and availability of space. It was not possible to obtain detailed information on this matter.

(c) <u>Frequency of delivery and collection.</u>

The empties are normally collected when beer or soft drinks are delivered to the retail outlet. However, it sometimes may not be possible to fit all the empties on the

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(4) For details of the procedure followed for obtaining this information on bottlers' experiences and practices, see footnote 1, page 332 and Appendix VII.

lorry in periods after peak sales (e.g., Christmas) so that some empties may then be left until the next delivery. Interviews with the transport managers at one soft drinks bottler and five breweries revealed that most deliveries are made every week or fortnight. The frequency of delivery depends to a certain extent upon the sales turnover of the outlet. The soft drink bottler said that he liked to have a minimum sales of five dozen bottles for each delivery, which might entail a period of three weeks between deliveries for some small outlets, but that he was willing to make more frequent deliveries if there was a shortage of storage space at the retail outlet.

Review of available evidence

Enquiries with three local Environmental Health Departments[5], the Ministry of Agriculture, Fisheries and Food's Pest Infestation Control Laboratory, two Supermarkets, the Institute of Grocery Distribition and the MFDRA have revealed no evidence of any sanitation problems occurring as a result of the storage of empty returnables. Thus, it appears that the potential sanitation problems are at present satisfactorily overcome by the efficiency of the regulatory activities of the EHOs, by the control measures

(5) For details of the procedure followed for the enquiries regarding this aspect, see footnote 2, page 332 and Appendix VIII. Appendix IX shows the list of the specific points on which information was sought on this subject from the retail trade.

and storage methods adopted by the retailers, and the frequency of collection of the empties. However, this absence of any evidence of instances and prosecutions for sanitation problems could also be due to the difficulties EHOs encounter in attempting to secure convictions for instances of sanitation problems. Therefore, in order to determine this aspect more definitively, further information would be required on the storage procedures customarily followed by a representative sample of retailers and an in-depth investigation would have to be made of any sanitation problems occurring at the retail outlets.

8.3.2 The significance of sanitation problems due to the storage of returned bottles.

The Environmental Health Officers and officials at the Department of Health and Social Security considered that the storage of empty returnables at the retail outlets does not currently represent a significant sanitation problem. The retailer's store room contains food items, such as confectionery, which are more attractive to vermin than the residues of beer or soft drinks in the empty bottles. Therefore, the EHO's activities and codes of conduct [e.g., Department of Health and Social Security (1972)] are primarily concerned with other aspects of food contamination and storage, such as the need to keep fresh meat separate from cooked meat and the maintenance of adequate storage facilities for cereals and flour.

Therefore, it appears that there would not be any significant sanitation problems arising under scenarios I-VI. However, these officials also stated that some problems might possibly arise if there was a very marked shift in the beverage market (e.g., due to a ban on the use of non-returnable containers for carbonated beverages) as depicted in the 100 per cent returnable system of scenarios VIII and IX and perhaps also the post-mandatory deposit legislation situation of scenario VII. In order to determine whether any sanitation problems would arise under these scenarios, further information would be required on:

- the retailers' expected turnover for the sales of beverages in returnable bottles and the number of bottles that would be returned to the retail outlet in 1982 under these scenarios;
- the availability of storage space at these retail outlets;
- the method that would be adopted by the retailers to store the empty returnables;
- the frequency with which the empties would be collected by the bottlers and brewers.

8.3.3 Limitations of the analysis

This analysis is limited by the lack of data on the incidence of sanitation problems occurring at retail outlets. This lack of basic physical data prevented the performance of a more detailed economic evaluation of these impacts. Nevertheless, some qualitative information has been presented which suggests that the storage of returned empties at the retail outlets does not currently represent a significant problem. Therefore, the lack of a more detailed monetary evaluation of these impacts should not constitute a serious omission for the analysis of scenarios I-IV.

However, it is considered that some sanitation problems might arise under Scenarios VII-IX. Section 8.3.2 highlights the information required to ascertain the nature and magnitude of these possible impacts. An economic valuation of these impacts could then be made by following the third stage of the methodology developed in Section 8.1

8.3.4 Conclusion

It is recognised that the storage of returned bottles at retail outlets could present potential sanitation problems since vermin could be attracted by the residues of beer and soft drinks in some bottles. However, at present, there is no evidence of any cases of such sanitation problems occurring in practice and it is the opinion of the authoritiative bodies concerned (e.g., the Environmental Health Officers) that the storage of the empty returnables at the retail outlets does not currently present a significant sanitation problem. Nevertheless, it is felt that some sanitation problems might arise if there was a marked shift in the beverage market (e.g., due to a ban on non-returnables) as depicted in the 100 per cent returnable system of scenarios VIII and IX and perhaps also under the post-mandatory deposit legislation situation of scenario VII. Section 8.3 identifies the further information required to ascertain the size and nature of any potential sanitation problems that might occur under such circumstances and Section 8.1 outlines a methodology for evaluating the significance of these impacts.

CHAPTER 9

ENVIRONMENTAL IMPACTS OF THE BEVERAGE CONTAINER SYSTEMS' TRANSPORT

Introduction

This chapter considers the environmental impacts caused by the transportation involved in the beverage container systems, which are highlighted in Figure 9.1. This figure shows that an important difference between the returnable and non-returnable systems in this respect concerns the return and re-use loop operated for the returnable system. Other important differences could arise from the transportation of the greater quantities of raw materials that are likely to be required for the non-returnable container systems. Concern has been expressed that an increased use of returnables might create significant environmental impacts, particularly as a result of the urban traffic congestion caused by the transport requirements of the return and re-use loop. [See Taylor (1980)]. Therefore, these impacts are considered separately in this chapter.

The environmental impacts of the beverage container systems' transport have been divided into the following four specific categories:-

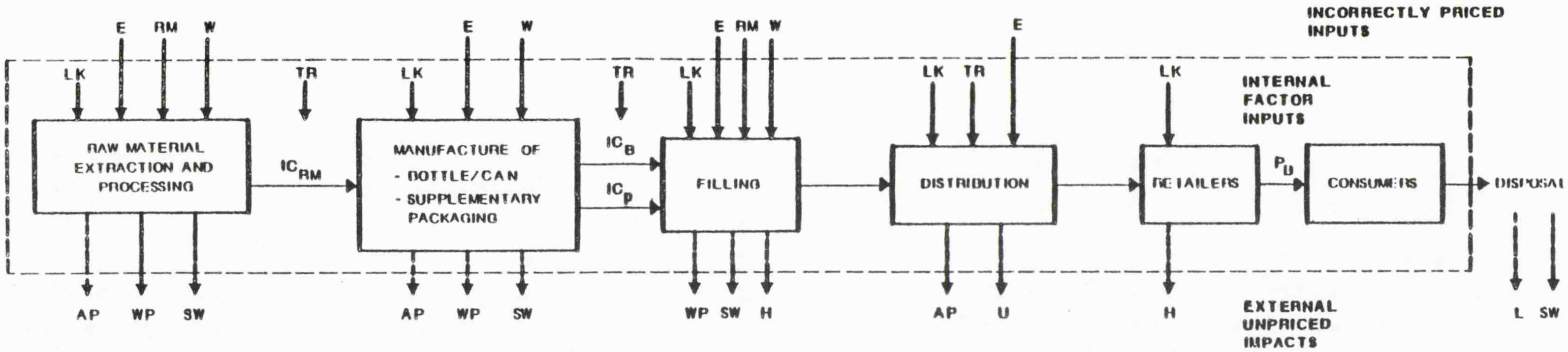
(i) Road track costs, which include public expenditures on the provision and maintenance of roads

(ii) Accidents

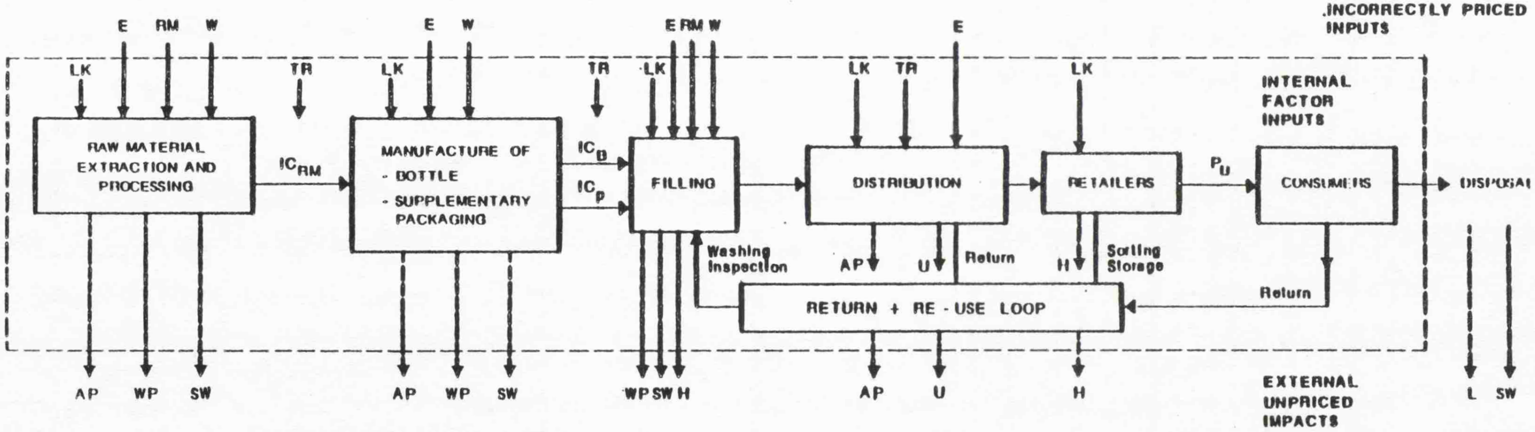
Figure 9.1

PROCESS STAGES IN THE RETURNABLE AND NON-RETURNABLE CONTAINER SYSTEMS FOR CARBONATED BEVERAGES

A. Non-Returnable Systems



B. Returnable Systems



Where Internal Input Categories

LK = Labour, capital, land (e.g. Space) and other factor inputs.
E = Energy.
RM = Raw materials.
W = Water.
TR = Transportation to next process stage.
IC_{RM} = (Internal) Cost or price of processed raw materials.
IC_B = (Internal) Cost or price of container.
IC_p = (Internal) Cost or price of supplementary packaging.
P_B = Price of packaged beverage to the consumer.

External Output Categories

AP = Air pollution emissions.
WP = Water pollution emissions.
SW = Solid wastes.
L = Litter.
U = Urban traffic congestion.
H = Hygiene impacts of any contaminants in the packaged beverage and from the storage of the beverage containers at the retail outlets.

(iii) Commercial vehicles' environmental impacts, such as noise and vibration

(iv) Congestion.

This chapter consists of five main parts:

- Section 9.1 first develops a proposed 'best available' methodology for evaluating each of these categories of external costs generated by the beverage container systems' transport . On account of the data constraints encountered during the research it has not been possible to follow through all the aspects identified in this 'best available' methodology. Consequently, this thesis had to concentrate upon examining the congestion arising from the delivery of beverages to the retail outlets.
- Section 9.2 then outlines the 'best practicable' methodology that has been applied for the evaluation in this study, and explains the rationale for the scope of the analysis and the methodology adopted.
- Section 9.3 estimates the level of beverage deliveries as a proportion of total goods deliveries in urban areas.
- Section 9.4 then assesses the significance of the congestion caused by the deliveries of beverages to retail outlets in urban streets.
- Section 9.5 highlights the limitations of this analysis.

9.1 Methodologies for evaluating the environmental impacts of the transport required in the beverage container systems

9.1.1 The development of a 'best available' methodology

9.1.1(i) Road track costs

The Armitage Report [HMSO (1980)] estimates that lorries account for over 90% of the damage to roads and comments that such road damage is a major issue in assessing the impacts of lorries.

The objective in investigating this aspect is to determine the external costs for the public provision and maintenance of roads that can be allocated to beverage container systems' transport. This examination should comprise an assessment of three aspects:-

(I) The transportation requirements of the total beverage container systems.

(II) The road surface damage caused by this transport and, hence, the road maintenance costs that can be allocated to this transport, plus the public expenditure on new road construction that can also be allocated.

(III) The fuel tax and vehicle excise taxes paid for this transport.

The external road track costs attributable to the beverage container systems' transport would then comprise (II) minus (III).

(I) The transportation requirements of the beverage container systems

In keeping with the need expressed in chapter 7 to investigate the total beverage container systems, the study should ideally cover the transportation required between all the process stages in the beverage container systems (i.e. from extraction of the raw materials through to the distribution of the beverage containers to and from the retail outlets - see figure 9.1).

Therefore, data would ideally be needed on the total transportation requirements of the alternative container systems. This should cover the following characteristics that are important determinants of the environmental impacts of this transport:-

- miles travelled
- mode of transport (road/rail/sea)
- type and size of lorry
- average laden gross vehicle weight
- distribution of the load on the lorries
- axle loadings on the lorries

This information is henceforth referred to as the base transport data for the beverage container systems. This is the fundamental building block for the evaluation of the environmental impacts of the transport requirements of beverage container systems.

If, as seems likely, it is not feasible to undertake extensive and detailed original research on the transport requirements of the alternative beverage container systems, then the research would have to be based on the currently available reports on packaging [e.g. Boustead and Hancock (1981)]. This would raise four problems. First, the data in these reports were collected for other purposes, such as the estimation of energy requirements, and consequently are not always in the appropriate form for a transport study. Second, it appears that the transportation between some of the process stages have not been included or have not been detailed separately in these reports. Third, assumptions or guesstimates have been made in the reports for important transport variables, such as: miles travelled, pay loads, and the type of distribution system analysed. These assumptions could be reasonable in the context of an energy analysis but would have important limitations for a transport study. Fourth, the reports frequently do not present data on the type and size of the lorry used, the axle loadings and the distribution of the load. It will be impossible to obtain detailed data on the last two aspects. Therefore, instead it would be necessary to make some assumptions [e.g. that the loads are distributed optimally in line with government standards - as is assumed in Department of Transport (1982a)]. However, this procedure may not be totally valid, especially for the distribution of full and empty returnable bottles to and from the retail outlets. On account of the fourth power law relating road damage to axle loadings, inaccuracies concerning these assumptions and 'guesstimates' could have significant effect upon the results. Therefore, further research would be required in order to verify these assumptions.

<u>(II) and (III) Determination of the external road track costs of beverage container systems.</u>

The external road track costs attributable to beverage containers would then be calculated by combining the basic transport data, from (I) above, with the Department of Transport (DOT) data on the allocation of road track costs and fuel and vehicle excise taxes [see DOT (1982a)]. It is considered that the resulting figure is likely to be very small and would become even smaller when the vehicle excise tax becomes based on laden rather than unladen vehicle weight so that a better allocation of road track costs among vehicles will be achieved.

<u>Limitations of the methodology</u>. The limitations of the figures generated under this methodology would primarily arise from the shortcomings of the base transport data,

especially the validity of the assumptions concerning axle loadings. In addition, it should be noted that the DOT data is for the allocation of public expenditures on roads so that this methodology will allocate road maintenance expenditures. However, these expenditures do not necessarily equal the total costs arising from road surface damage. In particular, the data do not include the social costs caused by increased road maintenance (e.g. delays, frustration, etc.).

9.1.1(ii) Accidents

There is considerable concern over traffic accidents, which are the largest single cause of accidental death [see the Armitage report (HMSO (1980)].

The evaluation of this aspect would require data on the vehicle miles required for the beverage container systems. These should be multiplied by figures for accident rates [see HMSO (1980), DOT (1981)] to give the numbers of different types of accidents caused by the beverage container systems' transport. An economic valuation of these accidents could then be derived by using the DOT's standard monetary values for accidents [see DOT (1982b)].

Limitations of the methodology. It would be desirable to apply this methodology with base transport data that was disaggregated in respect of the size of the lorries used and the type of road over which they travel, since the accident rate is lower on motorways than in built-up areas [see HMSO (1980)]. The extent to which such disaggregation can be achieved will be constrained by the availability of detailed data on the base transport requirements. It is doubtful whether the latter disaggregation will be feasible. Another limitation of this methodology concerns the use of the DOT values for accidents, which include a 'notional' sum for the intangible costs of pain, grief and suffering. This valuation has been criticised on account of its arbitrary nature [see Sharp and Jennings (1976)]. Nevertheless, in the context of a study on this particular subject, it is probably sufficient to obtain a rough indicator of the beverage container systems' accident costs by using the official DOT values. It is doubtful whether it would be worthwhile performing original research to determine more precise disaggregated data on accidents and then derive a more accurate figure for their value.

9.1.1(iii) Environmental Impacts of Commercial Vehicles

(a) Noise

Noise is regarded as being one of the most important environmental impacts of traffic in general and lorries in particular [see Transport and Road Research laboratory (1973 a,b, 1977), HMSO (1980)]. Thus the Armitage enquiry received more complaints about noise than about any other nuisance from lorries [HMSO (1980)].

This aspect might be tackled by using the base transport data and traffic noise models [see Transport and Road Research Laboratory (1973 a,b,c), Sharp and Jennings (1976)] to derive a physical measure of the noise from the beverage container systems' transport. However, consultations would be necessary with noise experts to ensure that the base tansport data was in the appropriate form so that it could be inserted into the noise models. Additional original research on the beverage container systems' transport requirements may be necessary for this.

The physical noise measures could be converted into a monetary value by using the results of the house price depreciation studies for traffic noise. These studies are reviewed in OECD (1983). In selecting the appropriate monetary value, it would be necessary to examine critically the various studies in the light of this valuation technique's limitations that were identified in chapter 3.

Limitations of the methodology. The study would have to be aggregative on account of lack of data relating to beverage container traffic flows on particular networks. Consequently, the physical noise measure may not be perfectly accurate since it might not take appropriate account of particular determinants of traffic noise levels, such as the gradient of the road, the state of the road, the existence of junctions and the flow of traffic [see Transport and Road Research Laboratory (1973 a,b)]. Furthermore, appropriate consideration may not be given to particular determinants of the impacts of traffic noise, such as number of people affected and their propinquity to the road and the nature of the area (e.g. residential/commercial/rural). Moreover, as was noted in chapter 3, the house price depreciation models suffer from a number of theoretical and practical difficulties. However, on account of the limitations of the base physical data, it would not be worthwhile to perform a more precise economic evaluation of the diverse noise impacts, especially since this would be difficult and costly. As a result of these limitations, this procedure could only give a rough order of magnitude 'guesstimate' for the overall traffic noise impacts of the transport required for the alternative beverage container systems.

(b) Other environmental impacts.

Other environmental impacts of transport include air pollution emissions, vibration and damage to underground pipes.

Air pollution emissions from the transport involved in beverage container systems are included in the pollution data given in Chapter 7. Therefore, they are not examined in this chapter.

The Armitage report found that fewer people were concerned about vibration than other environmental impacts of traffic such as noise, although the Transport and Road Research Laboratory (TRRL) reports the results of surveys which show a slightly different picture [TRRL (1973 a,b, 1977)]. It is difficult to determine the vibration impacts of lorries since the effects of vibration due to lorries depend upon many complex factors. The Armitage enquiry found that there is no comprehensive objective evidence on the incidence and effects of vibration from lorries on buildings [HMSO (1980)]. Similarly, the Armitage report states that little is known about the effects of lorries on underground pipes. Therefore, it will not be possible to perform either a physical or an economic evaluation of these other environmental impacts.

If a more precise economic evaluation of the environmental impacts of beverage container transport is required, then more detailed and accurate transport data would be required. Consumer survey techniques could then be considered for the evaluation of the overall environmental impacts of this transport, although care would have to be exercised to ascertain the extent to which the resulting value incorporated certain impacts, such as road track and accident costs, that could be treated as separate items for which some monetary valuations could be readily calculated.

9.1.1(iv) Congestion

Smeed (1968) has expressed concern over the problem of traffic congestion. Since then, the level of congestion in urban areas appears to have been reduced [see DOT (1978)]. Nevertheless, it still remains an important area about which particular concern has been raised in the context of beverage containers [see Taylor (1978)].

The objective of this study is to determine the economic valuation of congestion caused by the transport involved in the alternative beverage container systems.

A general methodology for achieving this objective comprises the following sequential steps: Collection of the base transport data; estimation of the propensity of the beverage container systems' transport to cause congestion; the resulting physical measure for the congestion impacts (e.g. in terms of vehicle minutes) could then be converted into monetary units by using the DOT's standard values of time [see DOT (1980)].

The application of this general methodology raises some major difficulties regarding the determination of the propensity to cause congestion. Like the other external costs of lorries, the congestion impacts are very much site-specific. The congestion impacts depend upon such factors as the width and gradient of the road, the traffic flow on the network and the availability of parking. Consequently, the impacts can vary significantly between different locations and also over different time periods. This raises considerable problems for any attempt to derive national estimates for the congestion impacts, especially since data collection constraints will probably prevent the acquisition of detailed transport data that is disaggregated between different types of road network. These gaps in the available data will then have to be filled by the use of assumptions, which in some cases may be rather heroic. As a result, any assessment of the congestion impacts arising from the alternative beverage container systems' transport could only generate approximate 'ball park' estimates.

A further limitation of this general methodology concerns the criticisms that have been levelled at the DOT's values of time[(1)]. However, in view of the likely shortcomings of the base physical measures of the congestion impacts, it would be valid to use the official values in the derivation of a rough indicator of the significance of these impacts.

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(1) For a review of the question of the value of time, see Heggie (1976) and Sharp (1981).

The propensities to cause congestion are best ascertained by examining separately the following four categories for the congestion impacts of lorries arising from:-

(a) Their extra width and poorer performance
(b) Their presence in the traffic system
(c) Their manoeuvring into and out of particular traffic streams.
(d) The loading and unloading of goods.

(a) <u>The extra width and poorer performance of the lorries</u>

The effects of the poorer performance of lorries could be estimated by using the results of earlier national studies on this subject [TRRL (1969, 1978)]. In addition to the base transport data outlined in Section 9.1.1(i), information would be required on the power to weight ratios of the lorries involved in the beverage container systems and also on the proportion of time the lorries are running with full loads. Precise information on these items will be difficult to acquire so that some assumptions may have to be adopted instead.

Alternatively, this aspect could be tackled by using the results of TRRL studies on delays caused by the extra width and slower speed of vehicles in the traffic stream [TRRL (1973a,b)]. However, it is not certain whether these results could be converted into an appropriate unit (e.g. congestion costs per vehicle kilometre) so that they could be used in combination with the base transport data.

(b) <u>The presence of lorries in the traffic system</u>

The Department of Transport's speed-flow relationships could be used to assess this aspect [e.g. see

Department of the Environment (DOE) (1971)]. This would yield average figures for the effect of an additional vehicle on traffic speeds on urban and suburban roads. Additional information would then have to be provided on the following items:

- The 'per car units' (pcu) value to be adopted for the lorries. Usually lorries are considered as being between two and three pcu, on account of their size and poorer acceleration. However, this involves some overlapping with (a). A figure of 1.5 pcu might therefore be appropriate for this specific aspect. This could yield an estimate for the impact on traffic speeds of each kilometre that the beverage container systems' lorries travel under less than free speed conditions;
- The typical traffic flows and speeds on urban and suburban roads;
- The proportion of roads on which lorries would affect traffic flows in peak and off-peak times;
- and the proportion of the mileage that the beverage container systems' lorries perform in peak and off-peak periods.

If, as seems likely, detailed data are not available on these items, then a number of assumption would have to be made. A particular limitation surrounding the assessment of this aspect is the compounding effects of any uncertainty concerning the validity of the various assumptions. Therefore, it would be necessary to enquire with experts in the transport sector and in the beverage industry to ensure that the assumptions are reasonable.

In addition, the speed-flow relationships themselves are subject to certain limitations [see DOE (1971)]. In particular, they only relate to traffic flows up to the limiting capacity of the road network and hence do not include the impacts in congested networks. However, such impacts are difficult to estimate for any study that is not site-specific.

(c) Manoeuvring into and out of the traffic stream

Three TRRL studies give figures for the delay costs caused by vehicles manoeuvring into and out of the main traffic stream [TRRL (1973a,b)]. These results could be used if these figures could be converted into an appropriate unit of measure that was compatible with the base transport data. The three urban streets studied in the TRRL reports may well not be representative since they are more likely to be prone to congestion than the motorways, rural and urban roads over which the beverage container systems' lorries typically travel. Consequently, this procedure might yield an overestimate for these congestion impacts of the beverage container systems.

(d) The loading and unloading of goods

The evaluation of this aspect would require data on the deliveries involved in the beverage container systems(2). It would be necessary to distinguish between deliveries that are made on the street and deliveries to an off-street loading/unloading area since the congestion implicatons of these two situations can be different.

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(2) This may entail the rather difficult determination of the beverage portion of a mixed load (e.g. a supermarket's own vehicle delivering beverage containers along with other goods).

'Off street' deliveries

The objective in assessing this aspect is to determine the economic cost of the impacts of the beverage container systems' deliveries upon other commercial vehicles that are held up in the queues in servicing areas, and also the congestion impacts upon general traffic where the queues of waiting lorries extend onto a highway.

The first step in this analysis would therefore be to identify those process stages in the beverage container systems where such queueing problems occur. Deliveries for the other process stages could then be omitted from this evaluation(3).

The second step would be to evaluate the congestion caused by the beverage container systems' delivery vehicles. Even after the study had been appropriately reduced in scope after the first step, this evaluation would still be difficult. Observation studies on beverage container delivery lorries might be used for this, although this would raise some important practical difficulties.

A significant increase in the distribution of beverages in returnables through the supermarkets, such as that depicted in scenarios VII, VIII and IX, might exacerbate the congestion problems at the loading bays. The evaluation of the impacts in this hypothetical situation would require

(3) This procedure might lead to the evaluation just concentrating upon the 'off' street deliveries of beverage containers to retail outlets (e.g. supermarkets) since the external queueing problems for other process stages might not be sufficiently significant to merit investigation.

additional information on: the number of supermarkets that would then stock the beverages in returnables and the quantities sold by these supermarkets; the procedures used for the delivery of beverages in returnables; the time taken to load and unload the beverages; the frequency with which the deliveries would be made; the current congestion situation at these supermarkets' loading bays and the effect that the deliveries of returnable beverage containers would have on these congestion levels.

'On-street' deliveries

Observation studies on delivery lorries might possibly be used to evaluate the congestion costs occuring when the lorries are parked in the street to load and unload goods. However, this approach is subject to important practical limitations. An alternative is to adopt the TRRL study on congestion costs arising from vehicles stopped to make deliveries in specific urban streets [see TRRL (1973a)]. This study yields an average figure for congestion costs per delivery in the street studied. Hence, if the average size of the beverage deliveries can be determined or assumed and an allowance made for any extra time involved in the delivery of returnables as opposed to non-returnables, then this information can be used to determine the congestion costs of beverage deliveries without requiring any additional base transport data.

9.2 The 'best practicable' methodology applied.

Data constraints precluded the performance of the stages identified in the 'best available' methodology presented in the previous section. In particular, there is a lack of base transport data for all the beverage container systems[4]. It was not feasible to perform the original research to obtain the additional data required, especially since the beverage industry was already faced with considerable demands for information from the other research teams involved in the WMAC study.

9.2.1 The scope of the study

This thesis concentrates upon evaluating the congestion impacts arising from the delivery of beverages to the retail outlets

Earlier freight transport studies [e.g., TRRL (1973a, 1973b), European Conference of Ministers of Transport (1976)] have shown that the parking of the lorries outside the retail outlets to unload was the principal source of the urban traffic congestion caused by goods vehicles. Moreover, in the context of the returnables vs non-returnable container issue, this represents the most important of the transport related external costs since it is in this area where there is likely to be the greatest difference between the returnable as opposed to the non-returnable systems and hence where a shift from the use of non-returnables to returnables would create the most significant impacts. Thus Taylor (1978 p.1) says that:-

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(4) In this respect, it is interesting to note that one of the research groups contacted (the Transport Operations Research Group at Newcastle University) had themselves considered studying the congestion impacts from the distribution of specific commodities. They found that such a study would present many formidable problems and consequently they did not pursue any in-depth studies of specific commodities.

"Concern has been expressed that a move from non-returnable to returnable beverage containers would increase traffic congestion in urban shopping areas. This would arise largely from the increased unloading time of the heavier returnable containers and the time required to load the empties."

9.2.2 The 'best practicable' methodology adopted

An estimate is first derived, in section 9.3 of this thesis, for the level of beverage deliveries as a proportion of total goods deliveries in urban areas. The following three approaches were considered for the assessment of the congestion caused by beverage deliveries :-

(I) Observation Studies
(II) Qualitative Assessment
(III) Provision of 'ball park' estimates

(I) Observation studies

A pilot observation study was undertaken on the soft drinks lorry of a bottler in Leicester. In this pilot study, the quantity of beverages delivered at each retail outlet was noted along with the traffic conditions there, and an attempt was made to record any congestion incidents arising from the deliveries. This pilot excercise demonstrated that such observation studies are subject to a number of important practical limitations[5]. It is difficult to measure accurately the congestion impacts of a delivery lorry upon other vehicles, especially where the observations are being done by just one person. TRRL have used cine cameras for their site-specific studies and these were inconspicuously

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(5) In addition, it is not certain that observers would be permitted on some other beverage delivery vehicles.

placed so as not to affect the drivers' behaviour [see TRRL (1973,a,b, 1974, 1975)]. However, the use of cine cameras would probably not be feasible for a vehicle-based rather than a site-specific study. Furthermore, it would be necessary to determine how the congestion impacts should be allocated between the vehicles involved. For instance, where the presence of an illegally parked car forces a beverage lorry to double park for the delivery and this prevents a large articulated lorry from passing which delays a number of cars (who could otherwise have passed the beverage lorry), then who is to blame for the congestion and to whom should it be attributed? The beverage lorry or the illegally parked car or the large articulated lorry?

An important limitation of the observation studies is that the actual level of traffic congestion resulting from beverage deliveries varies significantly depending upon a number of factors. Three major factors are: the availability of parking at the retail outlet; the traffic conditions at the retail outlet; and the delivery procedures followed by the bottlers/brewers and retailers. The first two factors can vary from one location to another and also between different time periods. This point was emphasized by the Multiple Food and Drink Retailers Association (MFDRA) who commented that there is no such thing as a meaningful 'typical' or 'average' retail outlet situation and that any analysis, which failed to acknowledge local variations, would 'paint a false picture'. Hence, it is necessary to take into account such variations and also whether the bottlers/brewers adjust their delivery procedures to allow for specific local circumstances. This means that the observation studies would have to cover a sufficiently large number of locations in different cities to enable the data to be in any way representative and applicable. This would make the use of such observation studies prohibitively expensive.

(II) Qualitative assessment

The question of how to tackle this area was raised at the meeting of the Packaging and Containers Steering Group of the Waste Management Advisory Council on 3rd July, 1978. At this meeting, the Steering Group recommended that no follow up observation studies on lorries should be undertaken, on account of the practical difficulties involved. Instead, it was suggested that, for the initial stages at least, the research should comprise a qualitative assessment of the significance of this aspect and that accordingly information should be sought from the distribution managers of breweries and bottlers who, with their wide experience of the many facets of beverage distribution, could give a good general overview of the congestion situation. If this research found that beverage distribution created significant urban congestion problems, then additional investigations might be undertaken to obtain quantitative data on these congestion problems and the other external impacts noted earlier might also be examined.

After liaison with representatives of the national associations of the brewing and soft drink bottling industries, a sample of five national and local breweries and three soft drinks bottlers was selected and the distribution managers at these bottlers and breweries were interviewed[6].

The author considered that it would be more meaningful and relevant if the opinions, on the significance of the congestion impacts of beverage distribution lorries, were obtained not only from the transport managers of brewers and bottlers but also from those public authorities engaged in the control of urban traffic congestion. Therefore, the opinions of these authorities on this matter are also reported in this thesis.

(III) Provision of 'ball park' estimates

This qualitative information is supplemented by the derivation of some approximate 'ball park' estimates on the basis of the monetary figures for congestion costs arising from deliveries in an urban street [TRRL (1973a)].

9.3 The level of beverage deliveries in relation to the total goods deliveries of in urban areas

The Greater London Transportation Study (GLTS) showed that about 20,000 deliveries of beverages were made daily in the Greater London area in 1971-72 [Fryer et. al., (1977), Saunders (1977)]. These beverage deliveries represented about 5 per cent of the total tonnage delivered. Another study found that there were 25 deliveries of beverages to Newcastle's shopping centre during the one-week

(6) Appendix X lists the areas where information was sought on this subject. Prior to the meetings, this list was sent to the distribution managers and information on these points was obtained in the course of the interviews.

period of the study [Smith (1976)][7]. This represented 2 per cent of the total deliveries.

However, the figures above include deliveries of other beverages (e.g., wine and spirits) as well as beer and soft drinks. Another study of freight movements in London [DOE (1968)] showed that beer and non-alcoholic beverages[8] accounted for approximately 2 per cent of the total tonnage delivered in London. The data above also include a large number of deliveries to the 'on' premise sector - notably to pubs - which, along with deliveries of other beverages, are outside the scope of this thesis. It is estimated that beverage deliveries to pubs and other 'on' premise establishments accounted for 7,000 of the total daily deliveries in the GLTS study, while there were 5,000 deliveries of all beverages (beer, cider, soft drinks, wines and spirits) to the 'off' premise retail outlets [Saunders (1977)].

This information suggests that the deliveries of beer, cider and carbonated soft drinks to the retail outlets constitute approximately 0.5 per cent of the total goods deliveries in urban areas.

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(7) It appears that both of these studies covered on and off street deliveries.
(8) This category did not include milk and dairy products

9.4 The Congestion Impacts of Beverage Distribution

The pilot observation study on a soft drinks lorry revealed that, during the day's delivery of 220 dozen bottles[9] of soft drinks, one slight congestion incident occurred when the parked beverage lorry impeded another lorry and three private cars. However, this pilot study relates to only one distribution situation which may not necessarily be representative of the overall position.

Enquiries with the distribution managers of five breweries and three soft drink bottlers, operating in four different parts of the country, revealed that the beverage distribution lorries do occasionally have to double park and do cause some congestion. Little detailed information is available on the number or nature of these congestion incidents. One bottler estimated that a congestion incident occurred about once in every 100 dozen bottles of beverage delivered by his lorries. One brewer stated that in the last five years he had not received any fines or complaints from traffic wardens about congestion incidents caused by his lorries. Another brewer said that he had only received one fine in the last five years, while a third brewer reported that he had received less than five fines in the past year.

These Distribution Managers also stated that urban traffic congestion does adversely affect their distribution

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(9) The day's load of soft drinks comprised 160 dozen returnable bottles and 60 dozen non-returnable bottles. The slight congestion incident occurred during the delivery of 5 dozen returnable soft drink bottles at a corner store in the central area of the city (Highfields). 3 dozen empties were also collected from this shop.

activities and that parking problems were encountered at some retail outlets. In some instances, the congestion prevents the draymen from being able to make the stop and deliver the beverages. Two London companies stated that this occurs in about 2 per cent of their deliveries. In such cases, difficulties are also created for the retailers who then suffer a delay in the replenishment of their stocks. Therefore, the bottlers, brewers and also some retailers have, of their own accord, taken certain measures to mitigate some of these problems.

Some retailers place 'No Parking Please' signs or empty cases outside their outlet in an attempt to reserve a parking space for the beverage lorry.

In organising their delivery schedules, the distribution managers take into account such factors as the times when congestion and parking problems are particularly severe and any traffic controls that apply at an outlet (e.g., time restrictions on loading/unloading). Hence, the distribution managers attempt to avoid delivering to specific outlets at the peak congested times of the day. Three or four men crews, instead of the normal two men crews, are used for delivering beer to particularly severely congested areas such as central London, so as to enable the loading and unloading to be completed as quickly as possible in these areas.

The distribution managers were asked for their opinion on the extra time that the lorry would have to spend parked outside the outlet to deliver the beverages in returnable bottles (and to collect the empties) as opposed to using non-returnable containers. The responses varied from 'the use of returnables would entail hardly any extra time' to 'the time spent at the outlet delivering returnables would be double that of the time required for non-returnables'. The average of the replies was that the use of returnables would require around 30-40 per cent more time to deliver beverages at the outlet.

The TRRL study of Putney High Street [TRRL (1973a)] gives an average congestion cost figure of about 5 pence per delivery to a shop in this street. If it is assumed that the average size of beverage deliveries in returnable and non-returnable containers is about the same and is 100 litres, then these congestion costs per litre of beverage delivered are about 0.05 pence (1973 prices), which is equivalent to about 0.1 pence in 1977 prices. It was reported earlier that about 30-40% more time is required for the delivery of beverages in returnables as opposed to non-returnables, so that the congeston costs for returnables have been increased accordingly to 0.13 pence per litre. This procedure assumes that deliveries of beverages in non-returnables are as likely to create congestion as the average delivery in the urban street studied and that the congestion impacts of beverage deliveries in returnable containers are (1.3 times) greater than the average. Smith (1976) found that the average duration of beverage deliveries was 28 minutes, while the average duration of all deliveries

Table 9.1

Congestions costs associated with deliveries to retail outlets of beverages in the different types of containers (pence 1977 prices)

BEVERAGE CONTAINER Type	Size	CONGESTION COSTS PER 1000 Containers	1000 Litres
Returnable	10oz	35.2	130
bottle	20oz	70.6	130
Non-returnable	10oz	26.3	97
bottle	20oz	52.7	97
Can	10oz	26.3	97
	16oz	42.1	97

Source: Derived from data in TRRL (1973a)

was 22 minutes so that this procedure is fairly reasonable[10].

Table 9.1 presents estimates of the congestion costs associated with deliveries of beverages in the alternative types of containers. The size of the various containers have been used to convert the figures for congestion costs per litre of beverage into terms of costs per container.

Table 9.1 indicates the low order of magnitude of these congestion costs (less than 0.1p per 20 oz returnable bottle) and also highlight the relatively small difference between the returnable and non-returnable containers' external congestion costs associated with this area.

(10) Smith (1976) did not specify whether these beverage deliveries were in returnable or non-returnable containers.

These rough 'ball park' estimates substantiate the findings of the surveys of the distribution managers and the official authorities concerned with traffic management and the control of traffic congestion (e.g., the transport section of the police, the traffic wardens and the councils' transportation and planning department). Both of these sources considered that beer and soft drinks lorries do not cause any significant urban traffic congestion problems at present. The officials also stated that they would not be unduly concerned about an increase in the use of returnables, such as that depicted in scenarios V-IX.

The relatively low congestion impacts of beer and soft drinks deliveries were attributed to the efficiency of the delivery schedules and distribution systems operated by the beverage industry and the speed with which the goods are unloaded by the 2, 3 or 4-man crews, especially at those outlets where the lorries have to double park and congestion problems can arise.

9.5 Limitations of the analysis

9.5.1 Limitations of the information and data presented

The analysis in the previous section had primarily to be based upon qualitative information, although the qualitative findings are substantiated by some approximate 'ball park' monetary guesstimates.

These 'guesstimates' have been derived from data in the TRRL (1973a) study which relates to deliveries in one high street of a London borough (Putney). These data may not be representative. The congestion impacts in this high street are likely to be greater than those for the 'average' situation for beverage deliveries. Therefore, these Putney-based figures overestimate the congestion costs arising from a typical beverage delivery. However, more precise values for such a 'typical' situation could not be determined on account of the impossibility of obtaining the required data covering the myriad distribution systems currently adopted for the delivery of carbonated beverages to the various retail outlets in different parts of the country. Nevertheless, these maximum 'guesstimates' still indicate the low order of magnitude of these impacts.

9.5.2 Omitted impacts

The analysis in the previous section is only partial since it only considers the impacts of 'on-street' deliveries of beverages to the retail outlets. Due to lack of data, it was not possible to investigate the following impacts of the transport involved in the alternative container systems:-

- Other congestion impacts, such as those arising from the presence of the lorries in the traffic stream and deliveries to off-street servicing areas. However, these other congestion impacts were considered to be less important than those arising from deliveries in urban streets and the previous section has indicated the low order of magnitude of these latter impacts.
- Road track costs, although it is considered that the external road track costs attributable to beverage container lorries would be negligible.
- Accident costs.
- Environmental impacts, such as noise and vibrations.

Therefore, the partial analysis in the previous section cannot yield an accurate measure of the transport-related external costs of the alternative container systems, especially since the returnable system requires more transport than the non-returnable system for the distribution of the containers to retail outlets but probably less for the earlier process stages. The retail distribution stage was selected for analysis in this thesis because this was the area where there was likely to be the most significant difference between the transport-related external costs of returnables and non-returnables. However, Table 9.1 shows that there is relatively little difference between the external costs of the alternative containers for this area. Therefore, it is unlikely that the inclusion of the other impact areas listed above would result in the transport-related external costs of the returnable system being significantly greater than those for the non-returnable system.

If it should be necessary to obtain a more precise valuation of the overall external costs of the transport required for the alternative beverage container systems, then the methodology developed in section 9.1 could be used for this.

9.6 Conclusion

This chapter concentrates upon assessing the congestion impacts occurring when the beverage lorries are parked in the street to deliver carbonated beverage containers to the retail outlets. Beer and carbonated soft drinks deliveries to the retail outlets are estimated to constitute about 0.5 per cent of total goods deliveries in urban areas. Enquiries with the distribution managers at eight breweries and soft drinks bottlers have revealed that beverage lorries do cause some traffic congestion. However, data are not available on the number or nature of these congestion incidents. The distribution managers along with the official bodies concerned with the control of traffic congestion (e.g., traffic wardens, traffic police, etc.) both consider that beverage lorries do not cause significant urban traffic congestion. The officials also stated that they would not be unduly concerned about an increase in the distribution of beer and soft drinks in returnable bottles.

These findings were substantiated by some 'ball park' guesstimates which indicate the low order of magnitude of the congestion costs arising from beverage deliveries. It is acknowledged that this qualitative information and the 'ball park' guesstimates have some limitations, which are identified in section 9.5. Section 9.1 also develops a possible methodology of how a more detailed economic evaluation could be made of this and the other transport-related external costs of the beverage container systems, if such more precise economic evaluations should be required on this subject. It is highlighted that the acquisition of the data required for this would be difficult.

A Social Appraisal of the Environmental Impacts of Returnable and Non-returnable Containers for Carbonated Beverages

by J.C.D. Fisher

Abstract

This thesis first reviews the economic literature concerning market failure. A best practicable approach to the evaluation of environmental impacts is then developed. This draws on the beneficial aspects of the various techniques, while taking into account their disadvantages and the practical constraints surrounding the acquisition of data. This 'best practicable' approach entails the performance of economic evaluations for as many as possible of the impacts and the provision of physical data supplemented by qualitative information on certain unquantifiable impacts. This approach is then adopted for the assessment of a specific market failure: the environmental impacts of returnable and non-returnable carbonated beverage containers. The analysis covers: the generation of domestic waste; litter; industrial solid wastes, air and water pollution emissions; public health impacts; and urban traffic congestion resulting from the distribution of beverage containers to the retail outlets. The analysis shows that the returnable system can generate less environmental impacts than the non-returnable container systems. Estimates are presented of the reductions in the environmental impacts of carbonated beverage containers that would result from a greater use and re-use of returnable bottles. The thesis reports the results of surveys of the opinions and practices of consumers, retailers, and bottlers/brewers. These surveys show that the low return rates or trippages in the United Kingdom are primarily due to the consumer's lack of knowledge that certain bottles are deposit bearing returnables and due to the difficulties many consumers encounter in returning bottles to retail outlets. Making it easier for consumers to identify and return 'returnable' bottles would appear to be a more effective method of raising trippage than increasing deposit levels.

VOLUME 2

P A R T V

TRIPPAGE

CHAPTER 10

TRIPPAGE

Introduction

It is evident throughout the theoretical framework presented in Chapter 4 and in the empirical analysis in chapters 5, 6 and 7, that the trippage of the returnable bottle is an important element in a social appraisal of the alternative returnable and non-returnable containers. Therefore, this aspect is examined in some depth in this chapter.

- Section 10.1 defines the term trippage.
- Section 10.2 summarises the information, given earlier in chapters 4 to 7, concerning the importance of the trippage of returnable bottles.
- Section 10.3, then reviews the available data on the trippage rates achieved by returnable bottles for carbonated beverages in the U.K. and in various other countries.
- Section 10.4 analyses the determinants of trippage. In particular, this section examines why some returnable bottles are at present not returned by U.K. consumers and then considers how the trippage rate of returnable bottles in the U.K. could be increased. A model of the determinants of trippage is first developed. This model is then tested empirically by the analysis of the results of surveys of consumers', retailers' and bottlers' attitudes and practices concerning the returning of bottles.

10.1 Definition of trippage

Figure 10.1

The flow of bottles in the beverage distribution system for returnable bottles

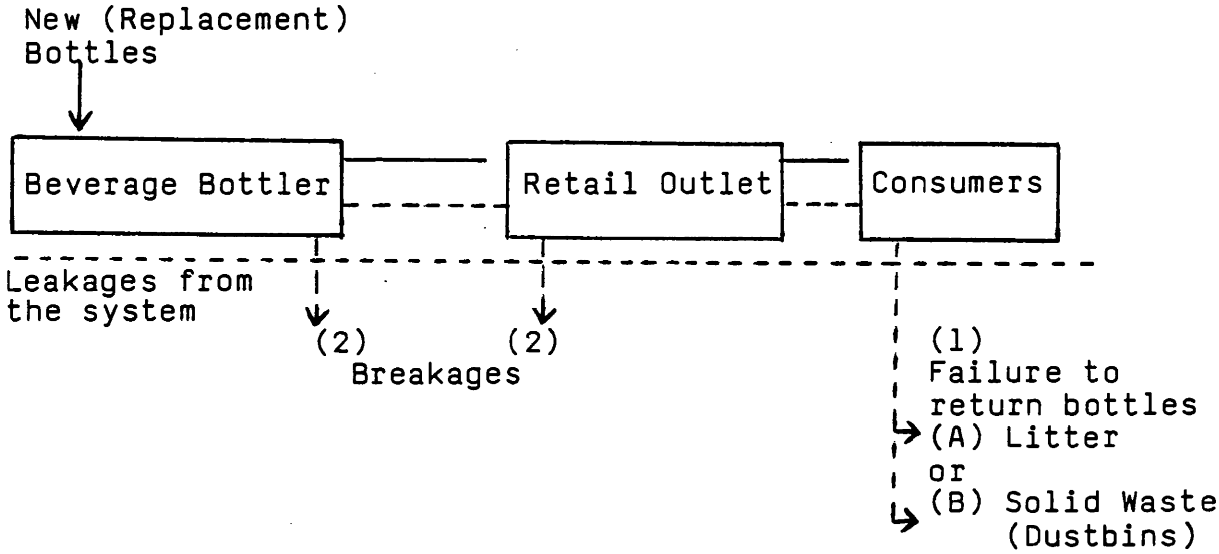


Figure 10.1 shows the flow of bottles in the returnable system for the distribution of beverages. Trippage is defined as the (average) number of times a returnable bottle is used for distributing beverages. This is the number of times that the bottle circulates around the beverage distribution system depicted in Figure 10.1, which also shows the possible leakages that could prevent the bottle from being re-used. The total trippage rate (T_T) is derived from the following formula:-

$$T_T = \frac{1}{1 - (ARR-APB)} \qquad 10.1$$

where:

ARR = The proportion of bottles returned by consumers.

APB = The proportion of bottles broken at the bottling plant, retail outlet or in transit.

A consumer trippage rate (T_c) is also frequently used in the literature [e.g., see Lidgren (1976), OECD (1978)]. This represents the number of times a bottle is returned by the consumers and is derived as follows:-

$$T_C = \frac{1}{1 - ARR} \qquad 10.2$$

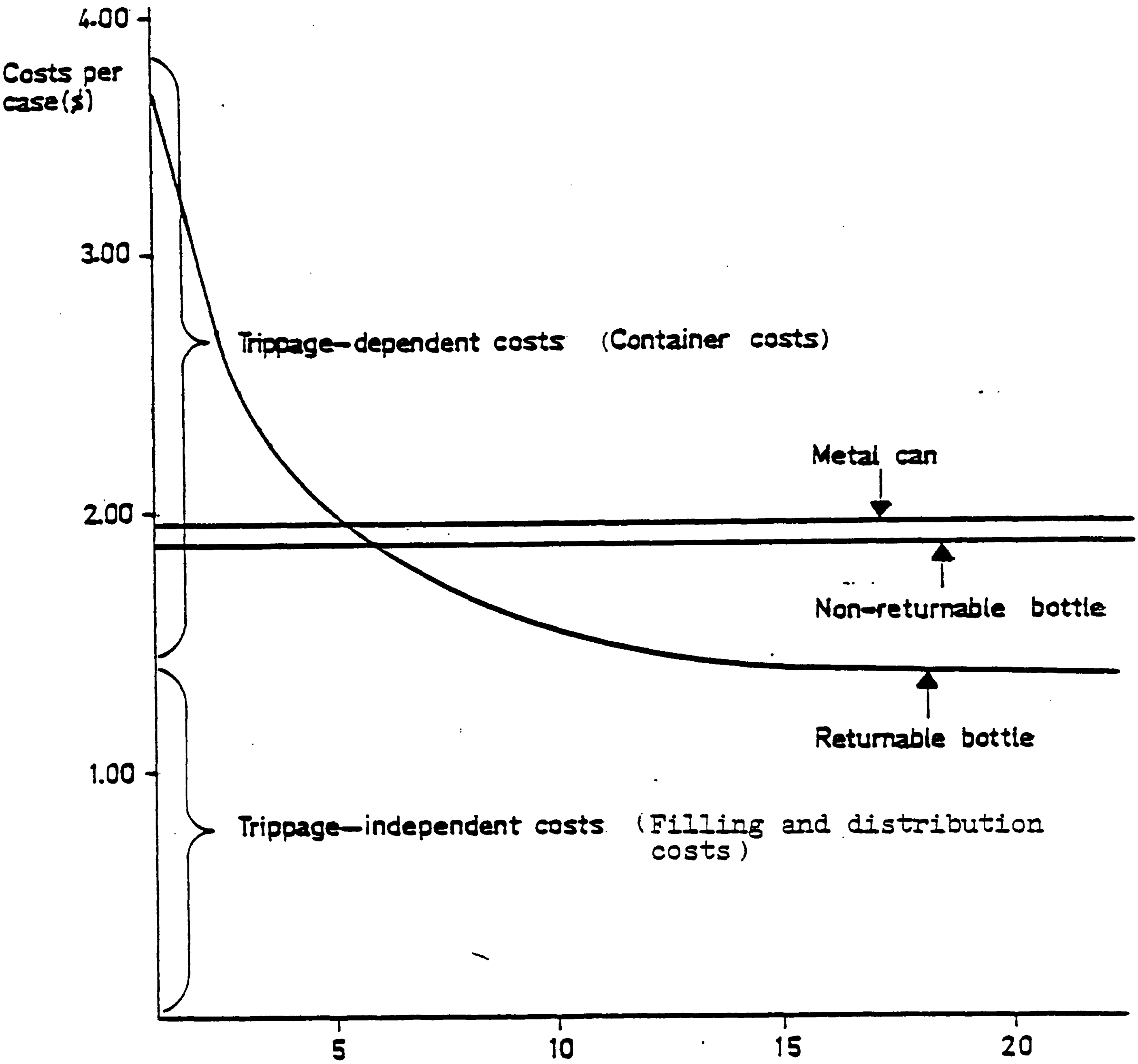
where the terms are as defined above.

10.2 The importance of trippage

This trippage is fundamentally important in determining whether the returnable bottle is the socially preferable container, in both economic and environmental terms. Generally, an individual returnable bottle is heavier and more expensive than its non-returnable counterparts and the returnable system incurs greater retailing and distribution costs. However, each time a bottle is returned for re-use, savings are achieved in the costs associated with the acquisition of the raw materials and their manufacture into a new container and, hence, in the total costs of supplying beverages in returnable bottles. This is shown diagrammatically in Figure 10.2.

Figure 10.2

Comparison of the internal costs of supplying packaged beer in non-returnable containers and returnable bottles with different trippages - U.S. (Oregon) Data for 1972 in US $ (1972 prices).



Source : Stern et al (1975)

Notes : (1) Trippage dependent costs are the costs that vary with the trippage rate i.e. the costs of the individual bottle which will be amortised by the number of trips achieved by that bottle. Trippage independent costs are those costs which are incurred regardless of whether a new or a returned bottle is used (e.g. filling and distribution costs).

(2) It would appear that a case contains 24 x 12 oz. bottles or cans.

The American data [Stern et al. (1975)], presented in Figure 10.2 show that the returnable bottle has to be used about five times in order to supply consumers with packaged beer at a lower cost, in financial terms, than the two alternative non-returnable systems. Detailed U.K. data on beverage distribution costs are not at present available to enable the appropriate figure for the cost break-even trippage for the U.K. beverage market(1) to be determined with any precision. However, the information in the OECD report [OECD (1978)] does indicate that, on account of the smaller transportation distances and the (relatively) lower labour costs in the U.K. than in the U.S.A., the costs of the actual container (and hence the trippage of a returnable bottle) will be relatively more important in the U.K. This importance of the trippage of a returnable bottle to an internal cost comparison of the various container systems in the U.K. is substantiated by the statement in the WMAC report [WMAC (1980, p.53)] that:-

> "It is clear that RB (returnable) systems have lower resource costs than non-returnable systems..... The main reason for this relative cheapness is the trippage achieved by the returnable bottle."

Similarly, it is apparent from Chapters 4, 5 and 7, that the external cost ranking of the returnable bottle in comparison with the non-returnable containers also depends crucially upon the trippage achieved by the returnable bottle. Table 10.1 gives the break-even trippages

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(1) However, a rough estimate of less than two for the cost break-even trippage for the returnable bottle was derived from data supplied by one U.K. brewer.

that the returnable bottle has to achieve to require less energy and generate less domestic solid waste, industrial solid waste, water and air pollution than the non-returnable systems. The external cost of litter is not included in table 10.1 since the rate of littering does not depend directly upon trippage. However, trippage could be significantly affected by the littering of a returnable bottle since, as can be seen in Figure 10.1, this littering is one of the possible leaks in the system that could prevent the bottle from being used again.

Table 10.2 presents a summary of the environmental impacts of various containers for beverages. This shows the marked effect of increases in trippage on the environmental impacts of the returnable system. Chapters 5 and 7 also highlight the effect of different trippage rates upon the environmental impacts associated with the supply of packaged carbonated beverages under the different (policy-induced) scenarios for the packaged beverages market.

Thus, increasing the returnable's trippage could aid the achievement of a viable returnable system and could lower the social costs of supplying the consumer with packaged beverages. This importance of trippage can be effectively illustrated in expression 10.3 below, where the cost minimising conditions for the attainment of the social optimum in the beverage container market are disaggregated into terms of the the costs incurred at the trippage dependent and trippage independent processes.

To minimise

$$[TIC_{NRB} + TEC_{NRB} + \frac{IC_{RB}^{B}}{T} + \frac{EC_{RB}^{B}}{T} + IC_{RB}^{F+D+R} + EC_{RB}^{F+D+R}] \quad (10.4)$$

where:-

RB	=	Returnable bottle
NRB	=	Non-returnable container
T	=	The trippage of the returnable bottle
TIC		represents the total internal costs of supplying packaged beverages
IC^{B}		represents the internal costs related to the container (comprising the costs of extracting and processing the raw materials, their manufacture into a new bottle and the delivery of the empty new bottles to the bottler).
IC^{F+D+R}		represents the internal costs of washing the bottle, filling it with beverage and the distribution and retailing costs (N.B. this also includes the costs for the supplementary packaging - crates - used for the distribution of the bottles).
EC_{RB}		represents the external costs related to the specified process stages of the returnable systems
TEC_{NRB}		represents the total external costs generated by the non-returnable systems

All the cost items above, are in terms of the costs of supplying a certain quantity of packaged beverage.

Therefore, it was emphasised in the framework for the social evaluation of beverage container policies in Chapter 4, that any policy should contain some effective measures to raise the returnable bottle's trippage. The following section assesses the trippage rates that are currently achieved in the U.K. beverage market and section 10.4.3 then examines some possible measures to increase trippage.

Table 10.1

Break-even trippages (T*) for the returnable bottle to have a lower environmental impact than 3 non-returnable container systems for beer and soft drinks.

Non-returnable Container	Environmental Impact					
	Energy	Domestic Solid Waste (Weight)	Domestic Solid Waste (Volume)	Industrial Solid Waste (volume)	Air Pollution	Water Pollution
Non-returnable bottle	2	1.5	1.5	1.5	1.2	7.2
Can						
- Bimetallic	1.5-4	7-9	2-3	0.7	1.6	14.8
- Aluminium	1.0-2	17-20	2-3	1.6	1.0	0.8

Source: US EPA (1974)

Research Triangle Institute (1976)

OECD (1978)

Data and information supplied by Metal Box Market Research Division

Chapter 5, Tables 5.9 and 5.10

Chapter 7, Table 7.11

Table 10.2 The Domestic and Industrial Solid Waste, Air and Water Pollution Emissions generated by the Distribution of 1000 litres of Beer in the Alternative Container Systems

EXTERNAL COST	BEVERAGE CONTAINER						
	Returnable Bottle				Non-returnable Bottle	Can	
	1-Trip	5-Trip	10-Trip	20-Trip		Bimetallic	Aluminium
Domestic Solid Waste							
Wgt (Kgs)	1056	211	106	53	704	148	$\simeq$ 63
Volume (m^3)	2.85	0.57	0.28	0.14	1.9	1.3	$\simeq$ 1.2
Industrial solid waste (m^3)							
EPA Study	0.42	0.11	0.07	0.05	0.29	0.61	0.27
Air Pollution(2) (weighted damage)							
EPA Study(1)	271.8	84.6	61.2	49.6	230.4	180.5	279.9
Basler and Hoffman Study	n.a.	n.a.	n.a.	76.1	145.8	126.5	-
Water Pollution (Kgs)							
EPA Study(1)	6.3	4.0	3.8	3.6	3.9	3.7	7.1
Basler and Hoffman Study	n.a.	n.a.	n.a.	0.9	6.1	14.9	-

Sources:- US EPA (1974)
- Basler and Hoffman (1974)
- Chapter 5, Table 5.9
- Chapter 7, Tables 7.2 and 7.9

(1) The container systems analysed in the EPA study required more supplementary packaging than is customarily used in the U.K., especially for the returnable bottles. Therefore the original EPA data has been adjusted to allow for this and some other important differences and these adjusted EPA figures are presented in table 10.2 above. The remaining differences between the absolute figures for pollution emission given in the two studies are primarily caused by differences in the assumptions and methodologies adopted by the separate studies. (A more detailed discussion of these pollution impact studies is given in Chapter 7).

(2) The quantities (in Kgs.) of each air pollutant emitted have been weighted by the ambient air quality standards for each pollutant to give the weighted damages presented in table 10.2 above.

10.3 Review of current data on trippage

10.3.1 U.K. data

Table 10.3 shows that the trippage rates in the U.K. beer, cider and carbonated soft drinks markets have been declining in recent years and that, in 1974, the trippage rates were approximately 13 for beer and cider and 9 for carbonated soft drinks. However, the calculation of the appropriate trippage figures poses a number of serious problems and there are two factors which must be noted in respect of these trippage figures.

The first concerns the selection of the appropriate formula to calculate trippage. The figures in table 10.3 were based upon the frequently adopted formula of:-

$$\text{Trippage} = \frac{\text{Total sales (unit fillings) in returnable bottles}}{\text{Total purchases of new returnable bottles}}$$

Purchases of new returnable bottles are the best surrogate measure currently available for the bottles that have not been returned. This formula will yield accurate trippage figures provided that there has not been any significant change in beverage sales in returnable bottles during the period under review. However, between 1970 and 1976, there was a 16 per cent drop in the level of beer and soft drinks sold in returnable bottles. The beverage industry will not need to purchase as many new bottles to satisfy this declining market so that this formula may yield an overestimate for current trippage rates and will understate the decline in trippage rates that has occurred recently.

Second, the figures given in table 10.3 are aggregate trippages for the whole beverage market. Recent surveys commissioned by the National Association of Soft Drink Manufacturers (NASDM) have revealed that there is a wide divergence between the trippage rates experienced by the various bottlers [NASDM (1976), WEYMES (1978)]. The trippage rates varied depending upon the size of the bottle, the type of outlet through which the beverages are sold and the location of the sales market. Lower trippages apparently occur for beverages sold in holiday resorts and in central areas of metropolitan cities.

Table 10.3

Trippage rates in the U.K. beer, cider and carbonated soft drinks markets

Year	Beer and Cider	Carbonated Soft Drinks
1930	?	20
1972	18	10
1973	15	10
1974	13	9

Source: Glass Manufacturers Federation (1973)

Data supplied by R. Cook, United Glass Containers Ltd.

The beverage markets contain two sectors: 'on' premise sales (e.g., in pubs or door-to-door sales) and 'off' premise sales (e.g., through off-licences and other retail outlets). These two sectors are distinctly different and therefore merit separate consideration, especially since any beverage container policy will primarily be concerned with the 'off' premise sector. The 'on' premise sector represents a closed loop return system where the return of the bottles is easy so that the trippage achieved in this sector is much higher than that achieved for 'off' premise sales, where the beverages are consumed away from the place of purchase and the consumer then has to take the bottle back to this place. The need to ascertain separately 'off' premise trippage was emphasised in a recent OECD report [OECD (1978, p.38)], which states that:-

> "However, without more concrete data this remains a tentative conclusion and obviously the 'off' premise trippage will take on different values for each country ...... The countries concerned should attempt to derive their own estimates."

Nevertheless, this OECD report does also acknowledge the practical problems of obtaining the data required to calculate 'off' premise trippage. Thus, the OECD report [OECD (1978, p.38)] comments that:-

> "Unfortunately, the calculation of disaggregated trippage figures for the different beverage markets is a very difficult and frequently impossible task."

Little research had been performed in this area, apart from an opinion survey of about 3,080 retailers commissioned by Metal Box in 1976 which gave a tentative estimate of 3-5 for the 'off' premise trippage for beer.

Therefore, a survey of retailers was undertaken in Leicester and Blackburn. This survey covered 69 retailers and incorporated the six main types of retail outlets for beverages (off-licences, Licensed Corner Stores, Greengrocers, newsagents, small and large supermarkets). These retailers were asked 'what proportion of returnable soft drinks/beer/cider bottles are returned to you?'. Table 10.4 presents the findings of this retailers' survey, which are fairly similar to those of the earlier survey by Metal Box. Both of these surveys may not yield perfectly accurate data on this subject since they are based on the estimates of just a limited number of retailers(2). Nevertheless, these separate surveys of retailers do at least give some indication that the 'off' premise trippage for carbonated soft drinks in the U.K., is currently of the order of 5, for cider is about 7 and for beer between 3-6. These findings are not inconsistent with the estimate for 'off' premise trippage of 4, which the WMAC adopted on the basis of NASDM's surveys [WEYMES (1978), WMAC (1980)].

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(2) It is uncertain as to the precise accuracy of these retailers' estimates of the return rates for bottles. Any inaccuracies in these estimates would have a marked effect on the resulting 'off' premise trippage figure. Thus, if the retailer's estimate for the return rate was 90 per cent, then this gives a trippage of 10, while the seemingly similar return rate of 95 per cent yields a trippage of 20. There was considerable variation among the return rates given by the individual retailers in the survey in Leicester, and also in the Metal Box Retailers' Survey. Therefore, the tentative 'off' premise trippage figures from these retailers' surveys should be treated with some caution. However, at present, no other information is available on this important area. Further detailed and more definite data are required on this subject.

Table 10.4

Retailers' estimates for the percentage of returnable beer cider and soft drinks bottles that are returned to them

Beverage	Bottle size	Retailers' estimate for the return rate of bottles	Weighted[1] average of all bottle sizes for each beverage: Return Rate	Trippage (T_C)
Soft Drinks	4-6 oz.	71%	79%	4.8
	26 Oz.	72%		
	litres/Qts	82%		
Beer	6 Oz.	94%	84%	6.4
	1/2 pt.	78%		
	1 pt.	87%		
	2 pt.	72%		
Cider	Quarts	86%	86%	7.1

Source: Survey of 69 retailers in Leicester and Blackburn.

(1) The return rates for each of the bottle sizes have been weighted by the retailers' sales of the beverage in returnable bottles of that size.

10.3.2 Overseas experience

Table 10.5 shows the trippage rates for returnable bottles that are achieved in a number of countries. In Norway, Denmark, Sweden and Canada (for beer), bottles are returned at the rate of 99%, 99.35%, 96% and 98% respectively. This yields consumer trippage rates (T_C) of 100, 150, 25 and 50 and, when allowance is made for the breakage rate of 1-3%, yields the total trippage rates (T_T) given in table 10.5. These data refer to aggregate trippage rates for the whole beverage market ('on' and 'off' premise sales). Data for 'off' premise trippage is, at present, only available for France, Sweden and Ontario in Canada (for beer), where consumer 'off' premise trippage rates are estimated to be about 12, 17 and 25 respectively(3)(4). Thus, French, Swedish and Canadian consumers return about 91%, 94% and 96% of their beverage bottles to the shops.

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(3) These estimates were derived from data given in PLM (1974), Lidgren (1976), Ontario Waste Management Advisory Board (1976), OECD (1978) and from correspondence with the Waste Management Branch of the Environmental Protection Service of the Canadian Government and from data supplied by Peat, Marwick and Mitchell Partners, Paris.

(4) The Swedish data refers to the year 1972, the Ontario data to 1975, and the French data to 1980. It is also estimated that, in 1976, the off premise trippage for beer and soft drinks in France was about 19. The data for the year 1980 has been used in the text above since, apparently, the estimates for 1980 are more accurate.

Table 10.5
The Trippage Rates achieved in Various Countries

<table>
<tr><th>COUNTRY</th><th>(Year for Data)</th><th colspan="2">Trippage (T_T)</th></tr>
<tr><th></th><th></th><th>Beer + Cider</th><th>Soft Drinks</th></tr>
<tr><td>U.K.</td><td>(1974)</td><td>13</td><td>9</td></tr>
<tr><td>FRANCE</td><td>(1980)</td><td>18</td><td>9</td></tr>
<tr><td>CANADA</td><td></td><td></td><td></td></tr>
<tr><td>ONTARIO</td><td>(1975, 1971)[1]</td><td></td><td></td></tr>
<tr><td>-Total Market</td><td></td><td>33</td><td>13</td></tr>
<tr><td>-Urban Centre</td><td>(1971)</td><td></td><td>5-7</td></tr>
<tr><td>QUEBEC</td><td>(1975)</td><td>33</td><td></td></tr>
<tr><td>UNITED STATES</td><td>(1973)</td><td>15</td><td>10</td></tr>
<tr><td>OREGON</td><td>(1973)[2]</td><td>6-20</td><td>12-24</td></tr>
<tr><td>SWITZERLAND</td><td>(1975)</td><td>60-80</td><td>20-70</td></tr>
<tr><td>GERMANY</td><td>(1975)</td><td>25</td><td>9</td></tr>
<tr><td>SWEDEN</td><td>(1972)</td><td colspan="2">17</td></tr>
<tr><td>FINLAND</td><td>(1975)</td><td colspan="2">30</td></tr>
<tr><td>NORWAY</td><td>(1977)</td><td colspan="2">35</td></tr>
<tr><td>DENMARK</td><td>(1974)</td><td colspan="2">31</td></tr>
</table>

Sources:

- OECD (1978)
- Ontario Waste Management Advisory Board (1976)
- Peaker (1975)
- Applied Decisions Systems (1974)
- PLM (1974)
- Data supplied by Peat, Marwick and Mitchell Partners, Paris

(1) The data for Ontario for beer relates to the year 1975, the soft drinks data to 1971.

(2) The figures for Oregon refer to 1973, after the implementation of the Oregon Bottle Bill legislation.

This is in marked contrast to the position in the U.K. where, as has just been shown, the 'off' premise consumer trippage is at present around four or five. Thus Cawdell (1980, p.7) states that:-

> "There is not a single country in Europe with beer or carbonated soft drinks trippages less than in Britain."

This distinct difference between the trippage rates achieved in the various countries raises the interesting question of what are the determinants of trippage and, in particular, what are the reasons for the U.K's low 'off' premise trippage rate. Thus the OECD report [OECD (1978, p.38)] concludes that:-

> "The marked divergence between the trippages experienced in different countries and different beverages, suggests a potentially fruitful avenue for research into the determinants of trippage. The returnable's trippage, and the means to increase it, is the central issue of the beverage container question. Therefore this research would be particularly valuable if it could effectively highlight the crucial determinants of trippage."

10.4. <u>Analysis of the determinants of trippage</u>

10.4.1 <u>Review of current information on the determinants of trippage</u>

Little research or analysis had previously been undertaken on the determinants of trippage, especially 'off' premise trippage. The reason conventionally given for the low return rate for bottles is that consumers 'cannot be bothered to return bottles'. Increasing the level of the deposits has been the main prescription which has been usually adopted in the past to raise trippage. The ineffectiveness of this conventional wisdom diagnosis and prescription is evidenced by the fall in trippage rates that has occurred in recent years, in spite of large rises in the deposit levels. This has resulted in increasingly large sums of money being lost by consumers in the form of foregone deposits on their returnable bottles. It is estimated that, in 1977, U.K. consumers lost about £18 million in deposits on the 267 million beer, cider and soft drinks bottles that were not returned (1977 prices).

10.4.2 Analysis of the determinants of trippage

Therefore there was a distinct need for a thorough study of the determinants of trippage. On the basis of U.K. and overseas' data and information on trippage, a behavioural model of the determinants of trippage was first developed in an earlier paper [Fisher (1978)]. This paper identified a number of factors that might determine the trippage of a returnable bottle. These include:-

I. Inplant breakages, which comprise:-
   (i) Breakages of bottles at the bottling plant, in transit and at the retail outlets
   (ii) Rejection of sub-standard bottles at the bottling plant
   (iii) Rejection of foreign bottles at the bottling plant

II. The consumers' (un)willingness to return bottles. This would be influenced by:-
   (iv) Any advertising campaigns for the return of bottles
   (v) The level of the deposit
   (vi) The consumers' valuation of the extra time and effort involved in returning bottles

III. The consumers' ease or difficulty of returning bottles. This would be affected by:-

- (vii) The distribution channel involved (i.e. 'off' premise or 'on' premise sales)
- (viii) The consumers' perception of the bottle as being a deposit-bearing returnable
- (ix) The existence of a standard returnable bottle
- (x) The retailers' policy and attitudes towards accepting returned bottles
- (xi) The market shares of the returnable and non-returnable bottles
- (xii) The supplementary packaging used for the sale of the beverages to the consumer

It is apparent that breakages are fairly small (about 1 per cent) and that they are not the major cause of the low trippage figures for the U.K. Thus, the Trippage Improvement Working Group of the Waste Management Advisory Council [WMAC (1980), Appendix IX, p.1-2)] reported that:-

> "Some accidental breakage or damage is bound to happen during filling, transport and use. There is sufficient data to suggest, however, that these causes are not responsible for the majority of bottle losses ..... failure to recover bottles from the consumer is the major cause of poor trippage. There is a considerable body of evidence showing that a marked improvement could be achieved in the trippage of returnable bottles, especially those used for beer and soft drinks, if the return rate from consumers could be increased."

Therefore, attention was concentrated on the second leakage in the returnable system. A number of possible hypotheses were drawn up concerning the consumers' failure to return bottles. These hypotheses were that consumers do not return returnable bottles because:-

(I) They could not be bothered to return the bottle

(II) It was not worth it for them to return the bottle.

(III) They experienced difficulties in returning bottles

(IV) They did not know that the bottle was a deposit-bearing returnable.

In addition, a number of possible hypotheses were drawn up concerning measures to increase the return rate. These hypotheses included:-

(1) Raising the deposit level
(2) Running an advertising campaign to encourage consumers to return bottles
(3) Standardisation of bottle shapes
(4) Making it easier for consumers to return bottles to the retail outlets
(5) Increasing the acceptance of returned returnable bottles by the retailers
(6) Providing the consumers with more information that a bottle was a deposit-bearing returnable
(7) Informing the consumer of where he could return a bottle for its deposit refund
(8) That an increase in the market share for returnable bottles might lead to a rise or a fall in trippage
(9) That nothing could increase the consumers' rate of returning bottles.

10.4.3 <u>Empirical testing of the model</u>

This model of the determinants of trippage and these hypotheses were then tested empirically by obtaining detailed information from the three parties involved in the flow of returned empty bottles from:-

(I) Consumers

⇓

(II) Retailers

⇓

(III) Bottlers/Brewers

The research consisted of four parts:-

(I) A questionnaire survey of 1,485 householders in Leicester and Blackburn and 43 school children in Colwyn Bay.

(II) A questionnaire survey of the opinions and practices of 69 retailers in Leicester and Blackburn.

(III) A practical bottle returning exercise, in which a random sample of 8 returnable bottles were taken back to 24 retail outlets in Leicester and the characteristics of the bottles rejected and accepted by each of these retailers were noted.

(IV) Interviews with five local and national bottlers.

10.4.3(i) <u>Consumers</u>

The consumers' surveys were undertaken in seven separate areas of Leicester and in nine areas of Blackburn(5). The surveys covered the major different types of housing areas (Council houses, terraced, semi-detached and detached houses). A letter was sent to each of the households in the selected areas explaining the purpose of the survey and informing them when the interviewer would be calling at their house(6). The response rate for the surveys in Leicester and Blackburn was 77 per cent and 66 per cent, respectively.

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(5) The household interviews in Leicester were undertaken personally by the author and his assistant, Paul Horton. The interviews in Blackburn were performed by the North West Waste Reclamation Committee of the Manchester Business School as part of their Blackburn waste survey project [see Mercer et al (1980)].

(6) A copy of the explanatory letter is shown in Appendix XI.

After consultations with the North West Waste Reclamation Action Committee, with representatives of the beverage and packaging industries and with those experienced in the design of questionnaire surveys, some revisions were made to an earlier draft and a final questionnaire was developed for the surveys (see Appendix XII).

The first part of the survey contained some specific questions about each of the beverage bottles shown in figures 10.3-10.7. The consumers were asked:-

(i) 'Do you buy any of these bottles?'

(ii) 'Can you tell me whether the bottles shown in these photographs are returnable or non-returnable, or if you do not know?'

(iii) 'Of the returnable bottles that you buy, what proportion do you actually return?'

(iv) 'Do you know what the deposit level is on each of the returnable bottles shown in these photographs?'

Their replies to questions (ii) and (iv) are presented in tables 10.6 and 10.7 below[7].

<u>Knowledge that a bottle was a returnable</u>

The surveys found that 6 per cent of the householders, who had purchased the returnable bottle in question, thought that this bottle was a non-returnable and a further 7 per cent did not know whether the bottle was returnable or

(7) A detailed analysis of the results of the survey in Blackburn is given in Mercer et al (1980). This report details the replies from different income groups and from residents in different housing areas.

non-returnable. Of particular interest are the replies from those consumers who did not return the returnable bottle. In over a third of the replies from this group, the bottle was not correctly identified as being a returnable, with 22 per cent regarding this 'returnable' bottle as being a non-returnable so that it is hardly surprising that these consumers had failed to return the bottle.

Knowledge of the level of the deposit on a returnable

Table 10.7 shows that 29 per cent of those householders, who had purchased the returnable bottle, replied that they did not know what the deposit level was on this bottle and over 80 per cent of those consumers, who did not return the bottle, either said that they did not know what the deposit level was on this bottle or gave a deposit level that was less than the actual level.

Thus, it is evident from tables 10.6 and 10.7 that consumers currently have a lack of knowledge about the returnable bottles present in the U.K. beverage market.

Many of the non-returnables have the words 'No Deposit No Return' embossed on the bottle or prominently printed on the label (e.g., see bottles No.3, No.9 and No.17 in Figures 10.3, 10.4 and 10.5). In contrast, many of the returnable bottles currently marketed do not have any similar feature to inform the consumer of the returnable nature of

Figure 10.3

The soft drinks bottles used in the Consumer Survey in Leicester.

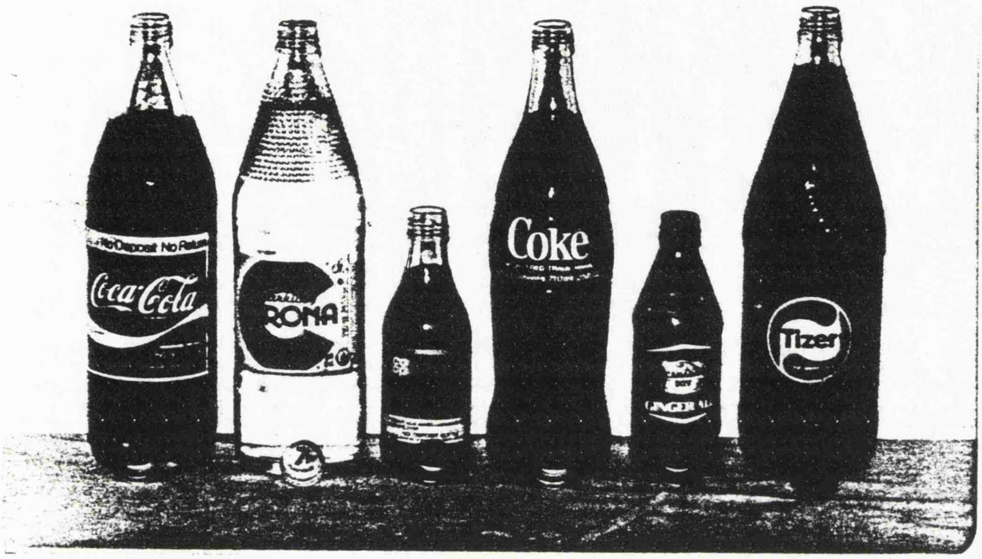
Bottle Nº 1 2 3 4

Bottle Nº 5 6 7 8

Note 1 : In the actual survey, 10" x 8" enlargements of these photographs were used so that the consumer was presented with a fairly life-size picture of the bottles.

Figure 10.4

The soft drinks bottles used in the Consumer Survey in Blackburn.



Bottle N° 9 10 11 12 13 14

Note 1 : See Note 1, Figure 10.3.

Figure 10.5

The cider bottles used in the Consumer Surveys in Leicester and Blackburn.

Bottle N° 15 16 17 18

Note 1 : In the Leicester Survey, 10" x 8" enlargements of this photograph were used. In the Blackburn Survey, 7" x 5" enlargements were used.

Figure 10.6

The beer bottles used in the Consumer Survey in Leicester.

Bottle Nº 19 20 21 22

Note 1 : See Note 1, Figure 10.3.

Figure 10.7

The beer bottles used in the Consumer Survey in Blackburn.

Bottle Nº 23 24 25 26

Note 1 : 7" x 5" enlargements of this photograph were used for the actual survey.

Table 10.6

The Householders' (HH's) Replies that the Returnable Bottle[1] was a returnable, a non-returnable, or if he/she did not know

Reply	All HH's who had purchased the returnable bottle	All HH's who did not return the bottle
Returnable	87%	64%
Non-returnable	6%	22%
Don't know	7%	14%

Source: A consumer survey undertaken in Leicester and Blackburn. See Fisher and Horton (1979), Mercer et al (1980), Fisher (1981).

(1) The sixteen returnable bottles in the survey are bottles Nos. 1, 4, 5, 8, 10, 12, 14, 15, 16, 18, 19, 21, 22, 23, 25, and 26 in figures 10.3-10.7.

Table 10.7

Householders (HH's) replies to the question

'Do you know what the Deposit Level is on each of these bottles[1]

HH's Reply concerning the deposit level on the returnable	% of Replies where (i)-(iii) was given by:- All HH's who had purchased the returnable bottle	All HH's who did not return the bottle
(i) Don't know	29%	52%
(ii) $<$ Actual level[2]	39%	31%
(iii) $>$ Actual level[2]	32%	17%

Source: As in table 10.6

(1) See note 1, table 10.6

(2) The actual deposit levels used in these calculations were the deposits at the time of the survey. These actual deposit levels were based on interviews with bottlers and retailers. They were as follows:-

Beverage	Bottle Type	(No. in Figs.10.3 - 10.7)	Deposit level
Soft Drinks	Corona	(1, 10)	7-8 p.
	Furnivals	(4)	8 p.
	Tizer	(5, 14)	8 p.
	Coke	(8, 12)	7-8 p.
Cider	All returnables	(15, 16, 18)	10 p.
Beer	1 pt. Newcastle Brown	(19, 23)	6 p.
	1 pt. Shipstones, Thwaites	(22, 26)	6 p.
	1/2pt. Tiger, Guinness	(21, 25)	4 p.

N.B. An actual deposit of either 7p or 8p was used for the Corona and Coke bottles since the deposits on these bottles changed just prior or during the course of the surveys.

the bottle or the level of the refundable deposit on it. Two of the soft drinks bottles and one of the cider bottles(8) selected for this survey did have such an identifying feature on their labels and the two soft drinks bottles also had the level of the deposit printed on the cap. These returnable bottles and their appropriate deposit levels were more often correctly specified by the consumers in the survey than were those returnable beverage bottles which did not have any such identifying feature. Thus, 55 per cent of the consumers who had purchased the Corona soft drinks bottle (No.10) specified correctly the deposit for this bottle which, as can be seen in figure 10.4, has the level of the deposit printed on the bottle top. While only 24 per cent of the consumers who had purchased the Coke bottle (No.12) specified correctly the deposit for this bottle, which used to have nothing on it to inform the consumer that this bottle was a deposit-bearing returnable(9).

<u>Information provided for the consumer at the shops</u>

The retailers' survey and the bottle returning exercise provided data on the information that the consumer receives when he buys the beverage at the retail outlet.

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(8) These are bottles Nos. 1, 5, 10, 14 and 15 in figures 10.3, 10.4 and 10.5. Another cider bottle (No.16) also had the words 'Deposit paid' on the label. But this was in such small print on the side of the label that very close inspection would be required on the consumer's part to enable these words to be discerned. Therefore, this bottle was classified as having no readily noticeable identifying feature.

(9) However, Coca Cola recently embossed on their new Coke bottles that these bottles are returnable.

The retailers surveyed were asked 'how they currently mark the prices of the beverages they sell in returnable bottles (either on their sales shelves or on the bottles themselves)'? For example, if the price of a pint of beer in a returnable bottle was 35p. and the deposit on the bottle was 6p., then do they mark:-

		In the example just given, this would be:
(a)	The (gross) price of the beverage <u>including</u> the deposit	= 41p.
(b)	The (net) price of the beverage <u>excluding</u> the deposit	= 35 p.
(c)	The (gross) price of the beverage inclusive of the deposit, but with the existence (and level) of the deposit on the bottle displayed as well	= 41 p. (including 6p. deposit)
(d)	The (net) price of the beverage, with the deposit on the bottle identified separately	= 35p.+ 6p.(deposit)
(e)	Neither price nor deposit marked	

In the bottle returning exercise, information was obtained on the price marking systems by a visual inspection of the retailers' bottles and shelves. The retailers' questionnaire survey and the bottle returning exercise yielded similar results, which are presented in table 10.8. This shows that most of the retailers, 55 in total, marked only the gross price of the beverage and did not indicate the existence or level of any deposit on the bottle. Presumably, this affects the consumer's perception of returnable bottles and their deposit levels.

Table 10.8

The marking by the retailers of the prices of beverages in returnable bottles and the deposit level on these bottles

Method of Marking Beverage Prices	No. of retailers(1) who currently use marking systems (a)-(e)
(a) 'Gross' price including the deposit	55
(b) 'Net' price excluding the deposit	4
(c) 'Gross' price but with the deposit identified	8
(d) 'Net' price of the beverage and the deposit level separately	4
(e) Neither price nor deposit	18(2)

Sources: A survey of retailers that was performed in Leicester and Blackburn
A bottle-returning exercise that was undertaken in Leicester
Fisher and Horton (1979)
Mercer et al (1980)
Fisher (1981)

(1) Some retailers used more than one marking system, i.e. different marking systems for different beverages.

(2) This category included twelve instances where the retailer did not mark the price or deposit level for the bottled beverage but the level of the deposit was already put on the bottle top by the bottler.

Effects upon trippage of changes in the returnables' market share

The survey found that the returnable bottles and their appropriate deposit levels were incorrectly specified more frequently by those consumers who purchased non-returnables as well as returnables than those who purchased only returnables. This finding gives some empirical support to the suggestion in the 'Financial Times' of 20th November, 1973, that:

> "It also seems that the non-returnable bottle, whose use has been spurred by supermarket traders, has made a considerable psychological impact on the British so that they now apparently assume that every bottle is to be thrown away when empty.."

If, in contrast to these recent trends, the market share of the returnable bottle was to increase then this could increase consumers' awareness of the returnable nature of the bottle. A high market share for returnables may also mean that the returning of bottles becomes an accepted and habitual part of shopping. In addition, an increased use of returnable bottles would probably result in a rise in the number of retail outlets which sell beverages in returnables and, hence, accept returned empties. This would make it easier for the consumers to return the bottle to an appropriate retail outlet.

However, this survey and earlier surveys [e.g., see Ontario Solid Waste Task Force (1974)] found that the purchasers of beverages in non-returnables and returnables currently return less returnable bottles than do the traditional purchasers of returnables. This gives further support to the earlier statement that the purchasers of non-returnables do treat the returnable bottles they buy as 'non-returnables'. However, this also means that a rise in the market share of the returnable bottle might have a (possibly short-term) negative effect on trippage as these purchasers of non-returnables switch to using returnables.

The net effect on trippage rates of these counteracting factors is uncertain. Nevertheless, table 10.9 shows that in those countries, such as Norway, Denmark and Canada (for beer) where the returnable bottle holds a large share of the beverage market, a high trippage rate is achieved; whilst in those countries, such as the U.K., U.S.A. and Canada (for soft drinks) where the returnable's market share is lower, a lower trippage rate is experienced. This gives some support to Cawdell's prediction that the implementation of mandatory deposit legislation would increase the market share and trippage of the returnable bottle [Cawdell (1980)].

Reasons for not returning bottles

All those householders, who had purchased a returnable bottle, were asked "if there was any particular reason why they do not return any or some bottles". Their replies to this question revealed that some householders could not be bothered to return the bottle or said that it was not worth it.

Table 10.9

The Total Trippage Rates(1) and Market Shares of Returnable Bottles in the Beverage Markets of Various Countries

	BEER			SOFT DRINKS		
COUNTRY		Returnable's Market Share	Trippage		Returnable's Market Share	Trippage
	Year	%		Year	%	
U.K.	(1972)	81	18	(1973)	64	10
U.K.	(1974)	73	13	(1974)	62	9
CANADA						
Ontario	(1972/5)(2)	98	33	(1971)	49	13
U.S.A.	(1970)	26	17	(1970	40	12
	(1973)	19	15	(1973)	35	10
GERMANY	(1975/6)(3)	93	25	(1975/6)(3)	91	9
SWITZERLAND	(1975)	95	60-80	(1975)	100	20-/0
DENMARK	(1974/5)(4)	97	31	(1974/5)(4)	99	31
NORWAY	(1975/7)(5)	99.7	35	(1975/7)(5)	99.7	35
FRANCE	(1976)	72	22	(1976)	83	15
	(1980)	58	18	(1980)	75	9

Sources:

- OECD (19/8)
- Ontario Waste Management Advisory Board (1976)
- Data supplied by Peat Marwick and Mitchell Partners, Paris
- Data supplied by Metal Box Market Research Division

(1) Table 10.9 relates to the total trippage rates (T_T) achieved in the aggregate (on and off premise) market for packaged beverages.
(2) For Ontario - for beer - the trippage data relates to the year 1975 while the market share data to 1972. However, it is considered that there has been little change in the market share of the returnable bottle in Ontario between 1972 and 1975.
(3) For Germany, the trippage data refer to the year 1975, the market share data to 1976.
(4) For Denmark, the trippage data refer to 1974, the market share to 1975.
(5) For Norway, the trippage data refers to 1977, the market share to 1975.

However, nearly twice as many householders said that they did not return a bottle because they experienced difficulties in returning bottles(10). There were three main ways in which these consumers find the returning of bottles difficult: some, especially older people, said that the bottles were heavy and awkward to carry; some consumers did not know that the bottle was a returnable bottle and many did not know where they could return the bottle to get the deposit refund on it; many consumers said that they encountered problems in finding a shop that would accept their returnable bottles. This last factor appears to have been the most important cause of the difficulties experienced by consumers. These consumers said that a retailer had refused to accept a returnable bottle which they had taken to the shop. Not surprisingly, more than half of these consumers gave up the attempt to return the bottle and threw it away.

Ease or difficulty of returning bottles

Further information on this aspect was obtained from these householders' replies to the next question: 'How easy or difficult is it for you to return bottles?'(11). Four per cent of the consumers replied that they found it very

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(10) A more detailed analysis of the results of the consumer survey in Leicester is given in an earlier published paper [Fisher and Horton (1979)].

(11) This question was asked after the question 'Is there any particular reason why you do not return this/these bottles?' so as not to lead to any bias in the reasons given by the householders for not returning bottles.

difficult to return bottles, 9 per cent said that it was difficult and 14 per cent said that it was a little difficult to return bottles. The respective figures were even higher for those consumers who did not return bottles, of whom over over a third (38 per cent) said that they found it very difficult or difficult to return bottles(12).

How to increase consumers' return rate

A principal objective of the survey was to assess how trippage, or return rates, could be raised. Therefore the householders were asked 'what would encourage you to return more bottles?'. Their replies are presented in table 10.10.

Thirty-four householders said that they would return more bottles if there was some positive promotion by the bottlers/brewers and the retailers of the importance and social benefits of returning bottles. Apart from a recent 'hand it back' campaign run by some soft drinks manufacturers, little has been done to demonstrate to the U.K. consumer that his returnable bottle is wanted back. This contrasts with the situation in Canada where the Ontario brewers and retailers run an extensive 'bring'em back' campaign (see Figure 10.8).

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(12) Of the eight householders, who said that they did not return bottles because they did not think it was 'worth it', 4 stated that the returning of bottles was difficult and 3 stated that it was very difficult to return bottles. This indicates that it was not 'worth it' for these consumers to return bottles in these difficult circumstances.

Table 10.10

Householders' (HH) replies to the question
'What would encourage you to return more bottles?'

	Reply	No of HH giving reply
(i)	Bottlers + retailers said that bottles were wanted back/adverts. campaign	34
(ii)	Easier to return bottles	285
(iii)	Higher deposit	167
(iv)	Uniform deposits	2
(v)	Government Action	14
(vi)	Nothing, return all now	97
(vii)	Nothing	7
(viii)	Other replies given(1)	29

Sources: Survey of consumers in Leicester and Blackburn
Fisher and Horton (1979)
Mercer et al (1980)
Fisher (1981)

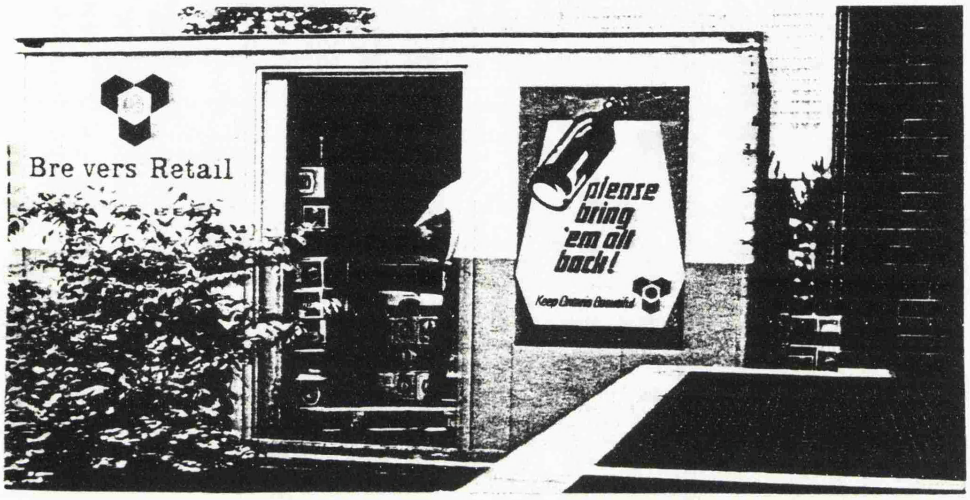
(1) These included 'shop not lose', 'discount on next purchase as well as deposit refund', 'lottery' and 'if bought more returnables'.

167 consumers said that increases in the deposit levels would encourage them to return more bottles. However, nearly twice as many (285) said that they would return more bottles if it was made easier for them to return the bottles. This suggests that the ease of return is more important than increases in the deposit levels. The deposit on a returnable bottle is supposed to encourage consumers to return the bottle by acting as a financial inducement to compensate them for the inconvenience of returning the bottle. However, the Consumers' survey revealed that over half of those consumers, who did not return bottles, did not know what the level of the deposit is and that a further 31 per cent specified a lower deposit level than the actual deposit level at present on these bottles (see table 10.7). Therefore, the current deposit levels are not acting as a very effective incentive for these consumers. Furthermore, in Oregon (USA) a higher return rate was achieved by a standard 'certified' beer bottle with a 2 cent deposit than by a non-standard beer bottle carrying a 5 cent deposit [Peaker (1975), OECD (1978)]. Thus, it appears that making it easier for consumers to return bottles (or, in other words, reducing the inconvenience of returning bottles) would have more effect on return rates than further increasing the deposit levels.

This importance of the ease of returning bottles is further substantiated by the experience in the beverage markets of various countries. In countries, such as Norway, Denmark and Canada (for beer) where it is relatively easy for

Figure 10.8

Examples of the extensive and effective advertising campaign run by the Ontario Brewers and retailers to encourage consumers to return bottles.



Source : Ontario Solid Waste Task Force (1974) consumers to return the standard bottles that are accepted by any shop selling that beverage, a high trippage is achieved by these bottles. Whilst in those countries, such as the U.K. and Canada (for soft drinks) where it is more difficult to return bottles to the retail outlets, a much lower trippage is achieved (see table 10.9).

Measures to make it easier for consumers to return bottles

The consumers in the survey mentioned five major factors which would make it easier for them to return bottles to the shops. These were:-

(1) More, or some, information on the bottle's label or at the shop that the bottle was a returnable bottle with a refundable deposit; and better knowledge of where the consumers could return the bottle to get their deposit back on it.

(2) If it was easier to carry the bottles back to the shop. In the U.K., returnable beverage bottles are usually sold across the counter to the consumer in individual bottles and some consumers find these individual bottles awkward to carry back to the retail outlet. In Canada, beer is sold in handy pack paper carriers in which it is convenient to place the bottles when empty and then return the carrier full of empties to the stores (see Figure 10.8). In Scandinavian countries (e.g., Denmark and Norway), returnable crates, which also carry a deposit, are used for the sale of beverages to the consumer. This contributes to the high return rates currently experienced in these countries.

(3) Closer shops.

(4) Standardisation of bottles.

(5) More consumers, however, said that it would be easier if they could take the returnable bottles back to any shop (i.e. standardized acceptance of beverage bottles by the retailers) and many consumers mentioned being able to return the bottle to more shops. This aspect was the most frequently mentioned factor by the consumers and would appear to be the most important way in which consumers feel that the return of bottles could be made easier for them.

10.4.3(ii) Retailers

The retailers have a central role in the distribution of beverage containers both to and from the consumer and the bottler/brewer. Hence, it was essential to obtain an input of their opinions into this study. Therefore, a survey was performed of retailers' attitudes and policies concerning returnable bottles. The survey covered the major types of retail outlets which sell carbonated beverages in those areas of Leicester and Blackburn that had been selected for the consumers' surveys. A good response rate was obtained (82 per cent for the survey in Leicester). The questionnaires[13] were completed by 69 retailers, in total, and the interviewers personally visited all these retailers which enabled them to give some useful clarification and elaboration to their replies.

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(13) Appendix XIII shows the questionnaires used for the retailers' surveys in Leicester and Blackburn.

Retailers' attitudes to handling returnables

Table 10.11 presents the retailers' replies to the question 'How do you feel about handling returnables and redeeming the deposits?' This shows that most retailers either do not mind handling returnables or consider it to be part of the job. Five retailers said that they positively supported the use of returnables. This was not only for environmental reasons but also for commercial reasons. These retailers said that the use of returnables attracts customers back into their shops as they return with the empty bottles. This is comparable to many retailers' current practice of giving special discounts on certain products (loss leaders) to attract customers into their store, only that with returnables the customers are also given a sum of money (the deposit on their bottles)(14) which they are then likely to spend in that shop(15).

However, many retailers (18 in total) said that they disliked the inconvenience and problems caused by the sorting, handling and storage of returned empties. Some of these retailers also said that redemption of the many different and frequently changing deposit levels on the various returnable bottles created administrative problems for them and that acceptance of returned bottles

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(14) At current deposit levels, this sum of money for a dozen returnable bottles can amount to more than £1.

(15) In addition, beverages in the cheaper returnable bottles offer a higher profit margin for the retailer [Cawdell (1980), personal communication with a soft drink bottler].

Table 10.11

Retailers' Attitudes to handling returnables

Retailers' response	No. of retailers[1] giving reply
Support use of returnables	5
No problem	2
Part of the job	4
Alright/Don't mind	31
O.K. but	6
Necessary but a nuisance	1
Causes problems	12
Dislike (inconvenience)	6

Source: A survey of retailers in Leicester and Blackburn.

(1) The total number of retailers replying to this question was 67. Two large supermarkets did not reply since they do not at present handle returnables. Presumably, these two supermarkets would come into the last category of disliking returnables.

could create cash flow problems as money was tied up idle in their stock of empty bottles on which the deposits have been refunded to the customer but not yet received back from their supplier.

Retailers' practices concerning the acceptance of returned bottles

The retailers were then asked whether they accepted all returnable soft drinks/beer/cider bottles that were brought to their store or only certain ones. Their replies to this question revealed that most retailers customarily place certain restrictions on the type of returnable bottles that they accept. The restriction most frequently stipulated by these retailers was that they would only accept returnable bottles of the same brand label that they sell. In many instances, retailers said that they would not accept bottles with the brand label of a different brewer or bottler even if, apart from this brand label, these returnable bottles were the same size and shape as those they sold. Other types of bottles which some retailers said they would not accept were: cracked bottles; bottles that were not re-usable; dirty bottles; bottles without a top; and bottles without a label. These restrictions appeared to vary depending upon the type of consumer who was bringing the bottles to the store. Thus retailers might accept any re-usable bottles, of the same size and shape as those used by their suppliers, from a regular or bona fide customer (i.e., someone who was likely to buy something). However, they would not accept these bottles from children. This information from the retailers' survey confirms the earlier findings of the survey of consumers, many of whom said that a retailer had not accepted a returnable bottle they had taken to his store. In particular, many of the children said that the retailers would not give them cash for the deposit on their returnable bottle but would only give them credit towards something they bought in the store.

Further detailed information on this aspect was obtained from a bottle-returning exercise, in which eight randomly selected returnable bottles were taken to 24 shops in the survey areas. The characteristics of these bottles were noted, along with the characteristics of the bottled beverages sold by the retailers. The bottles used in this exercise included many of the popular beer, cider and soft drinks bottles currently marketed(16). 130 of the bottles were rejected by the 24 retailers and 62 bottles were accepted. Furthermore, for 10 out of these 62 accepted bottles, the deposit given was less than the correct deposit refund on these bottles. Thus, on average, the retailers accepted between 2-3 and rejected 5-6 out of the 8 returnable bottles in each return exercise. A comparison of the characteristics of each batch of eight bottles with the characteristics of the bottled beverages sold by the retailer revealed some interesting information concerning the rejected bottles:-

(16) The details of the bottles used in this exercise are given in Appendix XIV.

(I) 17 rejected bottles were a different brand, shape and size to those sold by the retailer. The retailer could not have been expected to accept these bottles.

(II) 34 out of the rejected bottles had special distinctive shapes. The retailers sold the same beverage in the same size of bottle but in bottles with a different shape and brand name. Standardisation of bottle shapes might help to increase the trippage and life of these bottles.

(III) Six of the rejected bottles also had a different shape to those sold by the retailers. However, in these cases, the rejected bottles were standard and the retailers sold the same beverage in bottles of the same size but a different distinctive shape. Standardisation of bottle shapes might also help to increase the trippage of these bottles.

(IV) 46 of the rejected bottles, however, were the same size and shape as the beverage bottles sold by the retailer but were of a different brand name(17) (e.g., a standard lpt. beer bottle not being accepted by an off-licence which sold the standard pint beer bottles of another brewery). Standardisation of bottle shape would have no effect on the trippage rate achieved by these bottles, under this current situation concerning retailer acceptance of returned bottles.

(V) Nine rejected bottles were the same size, shape and brands as those sold by the retailers. The retailer said that he would not accept three of these bottles because, even though he stocked

(17) Six of these rejected standard bottles did not have a label.

the same brand (in fact Guiness), 'the bottle was not from my bottler' (the bottler's name was written in small print on the bottom of the label). Standardisation of bottle shapes would also have no effect upon the trippage of these bottles.

(VI) The remaining 17 bottles comprised eight rejected bottles which were the same brand but a different size than the beverage bottles sold by the retailers and nine instances where the retailer did not sell that type of beverage or did not sell the beverage in returnable bottles.

To sum up: It is evident that while a few retailers positively support the use of returnables since this attracts back into the shop customers who are likely to buy something, most of the retailers place some restrictions on the types of returnable bottles they accept from customers. The two main reasons given for stipulation of these restrictions were: 'their supplier would not accept the bottles'; and 'because the returned bottles cause problems for them'. These retailers were unwilling to perform the service of accepting returned empty bottles, which they find inconvenient and for which they do not perceive any compensation or rewards. Thus, there appears to be a marked reluctance to accept back empty bottles on the part of many retailers who stipulate these restrictions so as to reduce the number of returned bottles (and their concomitant problems) that they have to handle.

10.4.3(iii) Brewers and soft drink bottlers

The brewers and soft drinks bottlers want back as many as possible of their returnable bottles since this re-use saves them from having to buy a new bottle. Therefore some bottlers and brewers have taken some measures in an attempt to increase trippage. Thus, the National Association of Soft Drinks Manufacturers has recommended the use of a returnability symbol (shown in Figure 10.9), which has been adopted by some bottlers. Many others do now print words such as 'Please return bottle' on their labels (e.g., see Figure 10.10). In addition, some bottlers print on their bottle tops the level of the deposit charged on the bottle (as can be seen on bottle No.10 in Figure 10.4). These latter methods of identifying the returnable nature of the bottle and its deposit level are more noticeable and probably have a greater impact on consumer awareness than the returnability symbols which tend to be in rather small print on the bottom corner of the label, as can (just) be seen on bottle No.10 in Figure 10.4. The retailers' survey in Blackburn contained two questions about the effectiveness of this returnability symbol. 78 per cent of the retailers said that they had not seen this symbol before and 50 per cent considered that this symbol would not increase the return rate for returnable bottles.

It was pointed out by some brewers that their ability to change their labels is constrained by the costs of redesigning labels, and that the size of the labels on their (relatively small) bottles limits their ability to include any readily noticeable feature informing the consumer

Figure 10.9

The returnability symbol recommended by the National Association of Soft Drinks Manufacturers

Recommended symbol

for returnable bottles

(a)

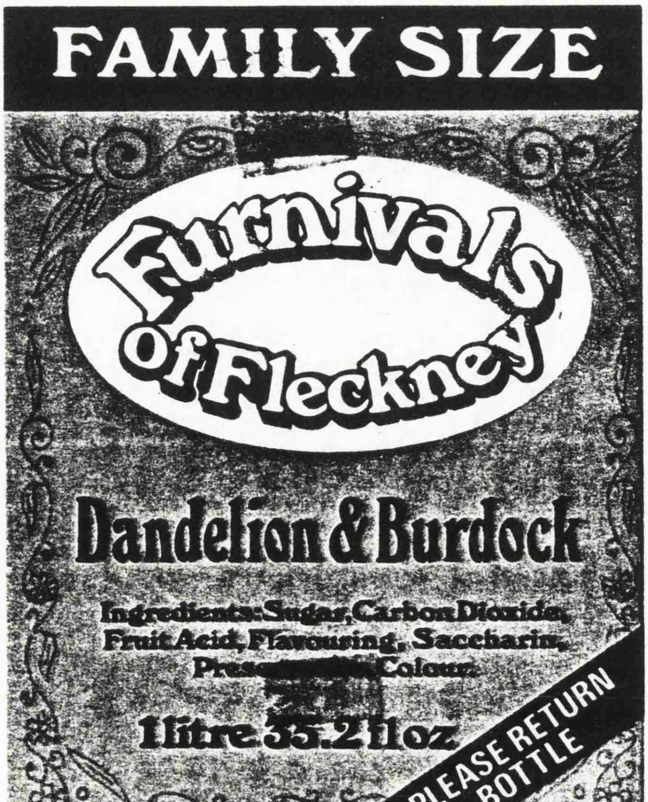
Actual size of symbol in use on some returnable bottles

(b)

NB: The symbol actually used on some bottles [(b) above] is less than half the size of the recommended symbol (a) above.

Figure 10.10

Example of the label of a soft drinks bottler identifying the returnable nature of the bottle and the need for it to be returned



that the bottle is a deposit bearing returnable[18].
Separate neck labels would be one effective method of displaying such an identifying feature, although this would involve some increase in the costs of labelling. Another alternative is the embossing of such words as 'Returnable Bottle' or 'Deposit Bottle, Please Return' on the actual bottle (as is currently accomplished on many milk bottles and also on the new returnable 'Coke' bottles recently introduced by Cola Cola).

10.4.3.(iv) Policy implications of the surveys

These surveys of beverage consumers, retailers and bottlers have some interesting implications for two important questions: 'Why consumers do not return bottles?'; and 'how the trippage of returnable bottles could be increased?'

(I) Why consumers do not return returnable bottles?

The consumers' survey showed that some consumers do not return bottles because they could not be bothered or are unwilling to return bottles. It would have been better, in both economic and environmental terms, if these consumers had purchased a non-returnable in the first place rather than their present failing to return a returnable.

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(18) Nevertheless, it was also noted that bottlers are willing to allocate valuable sales promotion space on their labels to state clearly "No Deposit, No Return" on the non-returnable bottles sold through supermarkets (as can be seen on bottle No.9 in Figure 10.4).

However, the survey also revealed that more consumers do not return the bottles because they experienced difficulties in returning bottles. These difficulties arose from two main sources:

(i) An apparent lack of knowledge amongst consumers that the bottle was a returnable with a refundable deposit on it, and about where they could return this bottle to.

(ii) The second, and most frequently mentioned, source of the difficulties was the problems that consumers encountered in locating a retailer who would accept their returnable bottles. Many consumers said that a retailer had refused to accept a returnable bottle they had taken to a shop. This finding was supported by the results of the bottle return exercises in which, on average, 5-6 out of each batch of 8 returnable bottles were rejected by the retailers. The retailers' replies in the questionnaire survey also showed that most retailers stipulated that they would only accept certain types of returnable bottles.

Thus, it appears that the reasons for the British consumers' failure to return bottles are more complex than the conventional diagnosis that consumers 'just cannot be bothered to return bottles'. These surveys also indicate that, rather than just accept these low and declining rates of returning bottles by U.K. consumers as being inevitable and irremediable, there are some positive measures which could help to reverse these current trends.

(II) How the trippage of returnable bottles could be increased.

Raising the deposit levels is the traditional remedy that has usually been adopted in an attempt to halt declining trippage. However, further increases in the deposit levels would aggravate the problems the deposit system presents for bottlers/brewers, retailers and consumers. Moreover, increasing deposit levels above their current levels would not be very effective at present since so many consumers either do not know what the deposit is on the bottle now or think that it is less than its actual level at present. The deposit is supposed to act as an inducement to compensate the consumer for the inconvenience of returning bottles. Therefore, rather than just raise the deposit levels, it would be more effective and efficient to alter this other aspect (the inconvenience of returning bottles) by making it easier for consumers to return bottles(19).

The Consumers' ease of returning bottles could be enhanced by two major measures:-

(i) Giving the consumers some more information that a bottle is returnable and has a deposit refund on it.

(ii) Increased acceptance of returned bottles by the retailers.

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(19) Reducing the inconvenience of returning bottles would also increase consumer welfare, as was pointed out in the policy evaluation framework in Chapter 4.

Identification that a bottle is returnable with a refundable deposit on it. Some soft drinks manufacturers do currently put such information on their bottle tops and labels. Other bottlers and brewers should give serious consideration, especially when they are re-designing their labels, to putting some readily identifiable feature on their labels or tops so that the consumer can see that a bottle is returnable and has a deposit on it. Such information should also be displayed in the shops and off-licences, where more retailers should clearly and separately identify the fact that the 'gross' price of beverages in returnable bottles includes a refundable deposit. This would enable those consumers, who are currently unwilling to return bottles, to see the actual sum of money that they are forfeiting by buying a returnable bottle and failing to return it for the deposit refund. This would encourage them to decide either that it is now worth it to return the bottle or, if they do not intend to return the bottle, to purchase a non-returnable.

Standardisation of bottle shapes, on its own, would not lead to a significant increase in the trippages of returnable bottles under the present circumstances in the U.K. beverage market where it is difficult for consumers to return both standardised and distinctively shaped bottles to the retail outlets. In the bottle returning exercises, standardised returnable bottles were rejected by the retailers as frequently as were the distinctively shaped bottles.

Increased (or standardised) acceptance of returned bottles by the retailers is also required. The results of the surveys in this study have indicated that if retailers were to accept more returned empty bottles, then this would ease the major difficulty that is currently experienced by British consumers in returning (or rather attempting to return) their bottles.

One possible method of achieving this would be through a voluntary agreement between the government, bottlers/brewers and the retailers. However, if such an agreement proved to be infeasible or ineffective in practice, then the use of either incentive or regulatory measures should be considered. One such incentive measure is the use of a differential deposit system whereby, for example, the retailers pay to the bottlers deposits of 72p per dozen of full beverage bottles and then receive deposits of 96p per dozen of empty bottles that they return to the bottler. The retailer would thereby receive a handling premium, in the example above, of 24p for each dozen empty bottles that he accepts from the consumers and returns to the bottler, who is thereby saved from having to buy more new bottles. The idea of such a differential deposit system or handling charge was examined in an earlier paper [Fisher (1981)] which was presented at a meeting of international scientists and experts. The experts at this meeting suggested that this handling charge should be set at the above figure of 24p. per dozen to cover the retailer's additional costs of handling the returned empties, which were estimated to be about 2p. per bottle.

Some consumers said that they would return more bottles if they received a discount on their next purchase as well as their deposit refund. Therefore, this differential deposit could perhaps be used by the retailers to finance such a discount so that, along with the deposit refund of 4-10p per bottle, the consumers also received an additional discount towards their next purchase of 1p. or 2p. for each returned bottle. Such an incentive measure might encourage more retailers to consider the positive sales generation benefits of performing the task of handling the returned empties.

Peaker (1975) reports that a system of differential deposits and handling charges was implemented in Vermont (USA). However, he also notes that this system in Vermont was less effective than the mandatory refund regulations of the Oregon Bottle Bill. Under these regulations, retailers and distributors have to refund the deposit on any carbonated beverage container if they sell the same kind and size of bottled beverage. Cawdell (1980, p.21) in his minority report to the WMAC advocates that such regulatory measures should be adopted in the U.K. However, the monitoring and enforcement of such regulations might present problems.

The Trippage Improvement Working Group of the Waste Management Advisory Council also recognised and emphasised the importance of securing an increased acceptance of returned empties by retailers and concluded (WMAC Appendix IX, p.5) that:-

"The idea of a 'handling charge' to cover the retailers' expenses does not seem appropriate. We assume that retailers stock returnables because it attracts business - products in returnables are frequently cheaper - and that the margin which the retailer applies covers his cost in handling the product including the return of the empty.....We think that any retailer selling products in returnable bottles should be obliged to accept those he has sold. We should like to urge retailers, whenever possible, to take back all bottles of the types stocked, although it would be unreasonable to oblige them to accept bottles of a type they do not handle."

The Working Group also suggested that the bottlers should work closely with the retailers, especially in relation to their schedules for collecting empties, to alleviate the retailers' problems connected with the handling of the returned empties. However, the Waste Management Advisory Council in the main text of their report did not make any specific recommendations concerning these proposals of the Trippage Improvement Working Group.

One of the above possible measures of achieving an increased acceptance of returned bottles by retailers would be a more effective and efficient method of increasing the trippage and life of a returnable bottle than further increases in the deposit levels.

10.4.3(v) Limitations of the surveys

These surveys have revealed some novel information on the two important questions examined in the previous section. Nevertheless, it should be noted that the consumers' and retailers' surveys centred upon just two areas of the U.K. (Leicester and Blackburn), although these consumers' surveys did cover the four main different types of urban housing, and the retailers surveys did incorporate the main types of retail outlets which sell beer, cider and carbonated soft drinks. Further follow-up surveys are still ideally required on the various issues that have been raised in this study in order to verify the results of these inevitably limited surveys.

10.5 Conclusion

Section 10.2 of this chapter has demonstrated the importance of the returnable bottle's trippage to the current controversy over returnable vs. non-returnable beverage containers. From the currently available data presented in section 10.3, it appears that the trippage rates in the U.K. beer and soft drinks markets have been declining in recent years and that they are lower than the trippage rates currently achieved in all other countries.

Section 10.4 then reports the results of surveys of consumers', retailers' and bottlers' attitudes and practices concerning the returning of bottles. The consumer surveys showed that the reasons for the British consumers' failure to return bottles are more complex than the conventional diagnosis that 'consumers just cannot be bothered to return the bottles'. The survey found that many of the consumers, who did not return a 'returnable' bottle, thought that this bottle was a 'non-returnable' and over a third of these consumers said that they had experienced difficulties in attempting to return bottles. The major cause of these difficulties are the problems encountered in locating a retailer who would accept their 'returnable' bottle. Many consumers said that a retailer had refused to accept a returnable bottle they had taken to a shop. This finding was substantiated by the results of a bottle returning exercise in which, on average, the retailer rejected 5-6 out of each set of 8 randomly selected returnable bottles that were taken to 24 shops in the survey areas. The questionnaire survey of retailers also showed that most retailers stipulate certain restrictions on the types of bottles they will accept so as to reduce the number of returned bottles (and their concomitant problems) that they have to handle.

Further increases in deposits above their current levels could not be expected to have much effect on trippage rates since at present most consumers either do not know what the deposit level is or think that it is less than its actual level now. A more effective method of raising the trippage of returnable bottles would be to make it easier for consumers to return these bottles. This would probably be best accomplished by giving the consumer some more information on the bottle's label and at the retail outlets that the bottle is a returnable with a deposit on it, and by achieving a greater acceptance of returned empty bottles by the retailers.

PART VI

CONCLUSIONS

CHAPTER 11

CONCLUSIONS

11.1 The theoretical foundations of the thesis

Chapter 2 demonstrates that the question of whether the government should consider intervening on an environmental issue depends upon the existence of any market imperfections, such as the existence of any significant externalities, the consumption of finite resources which are considered to be incorrectly priced under the current market mechanism and an absence of consumer sovereignty. However, government intervention to reduce these imperfections could have an adverse economic impact on industry and consumers. Therefore, in order to determine whether the government should intervene and, if so, by which policy measure, it is essential to make a comparative assessment of the environmental benefits (as represented by reductions in the levels of the externalities and the other market imperfections) and any economic impacts arising from all the alternative policy measures.

It is evident that an evaluation of the environmental impacts is important since this aids the determination of the desirability and degree of any government action.

Chapter 3 identifies the objective of valuing environmental impacts as providing information that will assist the policy-makers to ascertain the importance that society places on the environmental impacts under review. It is apparent that the various approaches towards the achievement of this objective have conceptual and practical limitations. It is demonstrated that the political approach may not be adequate for the assessment of complex issues. Thus it has become necessary to provide the political decision-makers with some more substantive information on these issues. Three quantitative methods of providing this information are examined: physical impact studies; economic evaluations, such as Cost-Benefit Analysis (CBA); and sophisticated weighting procedures, such as concordance analysis.

The physical impact studies can provide valuable, fundamental data and information on the physical impacts involved . However, this technique can lead to the presentation of a complex mass of data which can confuse rather than aid the decision-makers, who desire that the raw basic data should be filtered and presented in a meaningful form. In particular, the physical impact studies, on their own, do not provide any guidance on the significance of diverse impacts that are presented in different units of measurement. This presents an important 'Apples vs Oranges' valuation and comparison problem.

As strictly defined, CBA attempts to value all the impacts in terms of a common unit - money. An important benefit of such economic valuation techniques is that this use of a commensurable unit facilitates the aggregation and comparison of diverse environmental and economic impacts. However, there are considerable difficulties and practical constraints concerning the determination of monetary valuations for certain intangible impacts which may nevertheless still be important and should be appropriately taken into account in the final decision. Thus the public and the decision-makers are critical of the monetary weights assigned to such impacts and distrust the simple monetary conclusions generated by a strictly defined Cost-Benefit Analysis.

Significant practical problems are likely to be encountered in the performance of sophisticated weighting procedures, such as concordance analysis. Moreover, it is doubtful whether the decision-makers would be able or willing to comprehend these complex techniques and the (subjective) value judgements and assumptions involved in the computations. Consquently, the public and the decision-makers are likely to be even more distrustful of the quantitative conclusions generated by these techniques.

On the basis of the ideal objective and the practical problems of achieving it, chapter 3 then develops a 'best practicable' approach to the assessment of an environmental issue. This draws on the beneficial aspects of the various alternative approaches, while taking into account their disadvantages. This 'best practicable' approach comprises a sequential procedure which involves the following stages:-

<u>Stage I</u>: - Identification of the physical size of the environmental impacts. Where no quantifiable statistics can be obtained, a survey of the opinions of experts and official bodies should be used to give an indication of the order of magnitude of the physical impacts of the environmental pollutants.

<u>Stage II</u>: - Assessment of the significance of the physical impacts. This entails two steps:-

(i) First, a review of the opinions of experts and authoritative bodies on the significance of the environmental impacts;

(ii) then, if it is considered worthwhile and feasible, a detailed economic evaluation of these impacts.

The extent to which these sequential stages should be performed depends upon the relative benefits and costs of providing additional information in each particular case. This is determined by the current availability of data, the ease or difficulty of acquiring additional information, and the importance that is attached to the acquisition of this information.

This 'best practicable' approach entails the adoption of a broad interpretation of Cost-Benefit Analysis, under which economic valuations are made for as many of the impacts as possible. Nevertheless, it is acknowledged that in most cases there will remain certain impacts for which an economic evaluation cannot be performed. Physical data should be reported, supplemented by relevant qualitative information concerning the nature and significance of these unquantifiable impacts so that they can be appropriately assessed by the relevant decision-makers. In addition, an indication of the significance of these impacts could be given by the provision of approximate 'ball-park' monetary estimates, where this is possible.

It is acknowledged that this 'best practicable' approach still has some limitations. Nevertheless, chapter 3 demonstrates that the alternative approaches are all subject to major limitations, some of which arise from the practical constraints surrounding the acquisition of the data required for an evaluation of environmental impacts. In this respect, the 'best-practicable' approach can yield further benefits by highlighting those areas where the lack of data is particularly significant and hence where more research is needed to obtain the information required to evaluate the impacts in these areas.

11.2 Application of the general conceptual framework to the beverage container issue.

On the basis of the theoretical foundations of Part II, chapter 4 develops a framework for a social appraisal of the beverage container issue. This identifies three major criteria for the government to consider intervention in the market for packaged packages:-

- the existence of imperfect information and a lack of consumer sovereignty in the market for packaged beverages;
- the beverage container systems' consumption of finite resources, such as energy, which are considered to be incorrectly priced under the current market mechanism;

- the existence of any significant external costs.

This includes five areas:-

(i) the disposal of beverage containers in domestic waste;

(ii) the littering of beverage containers;

(iii) air and water pollution emissions and solid waste generated at the process stages involved in the beverage container systems;

(iv) public health and hygiene impacts arising from the presence of any contaminants in the packaged beverage and from the storage of the beverage containers (especially empty returnables) at the retail outlets;

(v) the environmental impacts resulting from the transportation between the process stages of the beverage container systems; in particular, the urban traffic congestion caused by the distribution of the beverage containers to the retail outlets.

Chapter 4 then illustrates how the 'best practicable' approach has been followed in the determination of the methodologies applied in this thesis for the evaluation of these external costs. This highlights the extent to which the sequential stages have been undertaken for the different external impacts in these areas. In addition, Chapter 4 identifies possible 'best available' methodologies that could be adopted if a more detailed economic evaluation of these impacts should be required.

Chapter 4 also demonstrates that the selection of the optimum policy for beverage containers necessitates an evaluation of the environmental and economic impacts of all the major policy options in comparison with the base line 'NO ACTION' situation. The environmental impacts are represented by changes in the external costs of beverage containers and changes in the beverage container systems' consumption of incorrectly priced finite resources, such as energy. The economic impacts will principally be reflected in changes in the total internal costs of packaged beverages, although it may also be necessary to give additional consideration to particular factors such as the policies' impacts on employment levels, capital investments and consumer (in)convenience and choice. It is evident that both the market shares of the alternative beverage containers and the number of times a returnable bottle is used for delivering beverages - or its trippage - will play an important part in determining the level of the internal and external costs of beverage containers. Therefore, in the formulation of the optimum beverage container policy, important consideration should be given to these two factors that a policy measure can alter.

11.3 The empirical analysis of the external costs of carbonated beverage containers

11.3.1 The 'external' nature of the major externalities relating to beverage containers

Chapters 5 and 6 demonstrate that the external costs created by solid waste and litter include both the financial costs incurred by the authorities for the management of solid waste and the control of litter, as well as the environmental impacts of the authorities' waste management techniques and the aesthetic impacts of the residual discarded litter that is not (immediately) collected. Similarly, the costs incurred by Environmental Health Officers for investigations into complaints concerning the presence of contaminants in a packaged beverage also constitute external costs.

11.3.2 The overall level of the major externalities relating to beverage containers

11.3.2(i) The external costs of domestic solid waste

The authorities' financial costs of collecting and disposing of the domestic and commercial waste generated annually in the U.K. amounted to about £393m. per annum in 1977-78 (1977 prices). These costs of solid waste management, along with the volume of solid waste generated, have been increasing rapidly in recent years, and it is predicted that these trends will continue in the future. There is increasing public concern over the environmental impacts of waste disposal. Many waste disposal authorities (especially in the major metropolitan areas) face severe difficulties concerning the location of waste disposal sites.

11.3.2(ii) The external costs of litter

Chapter 6 highlights the current lack of comprehensive data on the financial costs incurred for the control of litter. The available information suggests that the total costs of controlling and collecting litter were approximately £113m. per annum in 1977-78 (1977 prices). The 'litter' collected by the authorities includes some natural litter (e.g., sticks, leaves, etc.) as well as 'man-made' litter (i.e., litter discarded by humans or resulting from human activity). For the purposes of this study, the social costs created by 'man-made' litter is the more relevant statistic. However, the current lack of data is particularly significant in relation to the financial costs of controlling 'man-made' litter. It is estimated that the costs attributable to the control of 'man-made' litter were of the order of £50m. per annum in 1977-78 (1977 prices). This estimate was derived on the basis of the opinion of just one local authority and thus can only represent a best available 'guesstimate'. The authorities engaged in litter control consider that the costs of controlling litter (especially man-made litter) have been rising in recent years. It appears that there is increasing public concern over the aesthetic impacts of 'man-made' litter.

Thus chapters 5 and 6 highlight the concern over the increasing social costs created by the rising quantities of litter and solid waste. This concern has prompted a number of other countries' governments to implement policies affecting beverage containers. The latter are considered to be an identifiable product category in which the recent trend from returnables to non-returnables has contributed to the rise in the quantities of litter and solid waste.

11.3.3 The external costs of carbonated beverage containers

11.3.3(i) The contribution of carbonated beverage containers to the overall level of external costs for each area

Solid waste

Analyses of the composition of almost 100 tonnes of waste from more than 9,100 households, along with some materials balance calculations, have revealed that carbonated beverage containers constitute about 3-3.5 per cent of the total weight and about 2 per cent of the total volume of domestic waste.

Litter

A review of four litter composition surveys shows that these surveys do usefully complement each other, since two of the surveys have a larger and more representative data base, while the other two surveys have analysed more thoroughly the litter from specific locations. The surveys indicate that carbonated beverage containers constitute about 27 per cent of the total volume and 29 per cent of the total weight of littered material and about 11 per cent of the total number of littered items. It is considered that these surveys give a fairly reliable physical indicator of the carbonated beverage container component of 'man-made' litter, but that they might overestimate the size of the carbonated beverage container component of total (man-made plus natural) litter. The unit count measure of littered items probably gives a better indicator for the financial costs of collecting litter, while the volume measure reflects better the aesthetic impacts of litter. However, in addition to these physical statistics, it is also necessary to take into account the concern that has been expressed over the visual impacts of bright cans and injuries from broken glass. It is apparent from public opinion surveys and statements by authorities engaged in litter control that carbonated beverage containers are regarded as making a major contribution to the aesthetic impacts created by man-made litter.

Air and water pollution emissions

No quantitative data are available on this aspect. Nevertheless, it is considered that the pollution from the beverage container systems does not represent a significant portion of the total national pollution load.

Public health and hygiene

Complaints about beer and soft drinks containers represented about 0.03-0.4 per cent of the total cases of food contamination investigated by two local Environmental Health Departments.

Urban traffic congestion

Beer and soft drinks deliveries constitute about 0.5 per cent of total goods deliveries in urban areas. Beverage lorries do apparently cause some congestion incidents. However, no systematic statistics were available to enable determination of the size of the beverage containers' contribution to total urban congestion.

11.3.3(ii) Physical measures of the environmental impacts generated by carbonated beverage containers

Table 11.1 presents estimates of the quantities of carbonated beverage containers in domestic waste in the U.K. in 1977 and 1982. The figures shown in Table 11.1 for industrial solid wastes and air and water pollution emissions have been derived by adjusting the data in an EPA study [US EPA (1974)] to allow for the major differences between the container systems analysed in the EPA study and the position in the U.K.

Table 11.1

The quantities of carbonated beverage containers in domestic waste and the water and air pollution and industrial solid waste generated annually by the container systems for carbonated beverages in the U.K. in 1977 and 1982

External Cost	Units	1977	1982 Forecast(2)	% Increase over 1977(3)
Domestic waste	'000's tonnes p.a.	519.4	693.9	+34%
Domestic waste	'000's m^3 p.a.	2109.4	2910.0	+38%
Industrial waste	'000's m^3 p.a.	731.0	997.0	+36%
Water Pollution	'000's tonnes p.a.	8.6	11.3	+31%
Air Pollution	Weighted Damage(1) p.a.	339.0	483.0	+43%

Sources: Data in US EPA (1974)
Chapter 5, Table 5.12 and Chapter 7, table 7.12 (main text)

(1) The air pollutant emissions, in kgs. have been weighted by the ambient air quality standards for each pollutant to give the measures of pollution damage shown above (see chapter 7, section 7.2 of main text).

(2) This is the scenario II 'NO ACTION' situation that is forecast to occur in the packaged beverage market if there is no government intervention.

(3) Scenario II does not allow for any reductions in container weights and pollution coefficients due to any technological improvements that might occur between 1977 and 1982. Therefore the increases shown in the last two columns represent maximum estimates.

11.3.3(iii) Evaluation of the external costs of carbonated beverage containers

Chapters 4 and 5 highlight that there is some uncertainty about whether the average or the marginal cost of controlling externalities (e.g., waste management) is the appropriate measure to be used in an evaluation of the external costs of beverage containers. Consequently, an attempt has been made in this thesis to perform the evaluation on the basis of both the average and the marginal cost measures.

Little quantitative data is currently available on the 'marginal' costs of waste management and it was only possible to report some qualitative information and opinions on this important subject in chapter 5. It is generally considered that the marginal costs of collecting waste are low. In relation to waste disposal costs, many waste disposal authorities face severe problems over finding suitable landfill sites for the disposal of the increasing volumes of wastes being generated. Consequently, many authorities are having to transport the wastes to more distant sites and are having to adopt more expensive treatment techniques (e.g., pulverisation, incineration, etc.) in order to reduce the volume of waste to be disposed. A reduction in the volume of waste generated would help to ease these problems. Therefore it has been suggested that the marginal costs of waste management are approximately equal to the current average costs of domestic waste disposal. This means that the marginal costs of solid waste management would be about £6.00 per tonne, in 1977-78, and would be about £10.00 per tonne in 1982-83 (1977 prices). In contrast, the average costs of waste management are estimated to be about £25.00 per tonne in 1977-78 and about £34.00 per tonne in 1982-83 (1977 prices). Thus there is considerable difference between the marginal and the average costs of waste management. This highlights the importance of raising this question, which is discussed in Chapters 4 and 5 of this thesis.

The choice of the appropriate measure depends upon whether: since an integral activity (such as the generation of domestic waste) does create external costs equal to the average costs of waste disposal and collection, then does a particular component of this integral activity also create external costs equal to the average costs?; or are the external costs of a particular product equal to the marginal costs of collecting and disposing of that particular product, since any reductions in the amount of this product in domestic waste would yield financial savings in waste management costs which would equal the marginal costs of waste management.

As yet, this question has not been resolved and not even faced neither in the current literature nor in the political fora. It would appear to depend principally upon whether the action concerning the particular product(s) is part of a general policy to reduce the overall level of the externality, as has occurred in some countries such as the Federal Republic of Germany. Similarly, on account of concern over the rising external costs of waste management, the US EPA proposed that a product charge should be levied on packaging - the major component (30-60 per cent) of domestic waste - to cover these costs and reduce the levels of waste generated [US EPA(1977)]. The level of this proposed charge was based upon the average costs of waste disposal and collection.

Chapters 5 and 6 show that there is considerable concern in the U.K. over the external costs of solid waste and litter. Consequently, the U.K. government embarked upon some sort of general waste management policy through its proposals on waste management [e.g., in the Green Paper War on Waste [HMSO (1974a)] and the Control of Pollution Act [HMSO (1974b)], and the provision of financial assistance and advice for recycling schemes [e.g., see National Anti-Waste Programme (1977)]. This gives some justification for using the average cost measure. However, the Waste Management Advisory Council conceived the beverage container study as being related solely to beverage containers. The WMAC was not concerned with the overall solid waste and litter problems, which suggests that the marginal cost measure should perhaps be adopted.

On account of the apparent uncertainty concerning this question, tables 11.2, 11.3, 11.4 and 11.5 present estimates for the external costs of carbonated beverage containers on the basis of both the average and marginal measures for abatement costs. Tables 11.2 and 11.3 show the total level of the external costs generated by carbonated beverage containers in 1977 and the forecast levels for 1982. These tables highlight a number of interesting points.

It is evident that the external costs of carbonated beverage containers will increase, in real terms, between 1977 and 1982. This increase is due to two factors. The first is the forecast trends of an increased use of non-returnables and a decline in the trippage of returnable bottles. This factor will result in an increase in the physical quantities generated, although the data in table 11.1 gives a maximum estimate for this increase since it does not allow for any reduction in the container weights and pollution coefficients that might occur between 1977 and 1982. Nevertheless, it is unlikely that any such reductions in container weights and pollution coefficient could prevent an increase in the external costs of carbonated beverage containers, especially on account of the second factor, namely the rise in the real costs of waste management, particularly waste disposal, that is predicted to occur in the future.

The data for domestic waste reveal the significant divergence between the external costs of carbonated beverage containers derived on the basis of the average cost measure (table 11.2) as compared with the marginal cost measure of waste management costs (table 11.3).

Tables 11.2 and 11.3 also highlight the paucity of the currently available data on the financial costs of controlling the externalities generated by beverage containers. Thus, on account of uncertainty about the available data, table 11.2 presents a range of estimates for the financial control costs for littered carbonated beverage containers under the average cost measure. The lack of data

Table 11.2

The external costs of carbonated beverage containers in 1977 (and estimates for 1982)
- 1977 prices - Average cost measure of the financial control costs.

External Cost Category	Monetised costs 1977 £m. p.a.	(1982) £m. p.a.	Residual (uncontrolled) External Impacts
Domestic Waste	10.2	(20.5)	Environmental impacts of waste disposal sites
Litter	5.1-13.0 (1)	(?)	Visual impacts of littered cans, injuries from bottles, broken glass, torn cans and ring pulls
Pollution emissions	?	(?)	See data in Table 11.1
Hygiene	? (but low)	(?)	No significant hygiene problems
Urban traffic congestion due to on-street beverage deliveries	$<$2.3 (2)	(?)	Other environmental impacts of the transport requirements (e.g. other congestion impacts road track costs, accidents, noise & vibration)

Source: Chapter 5, table 5.12; chapter 6, table 6.3; chapter 9

(1) A range of figures has been presented for litter on account of the uncertainty concerning the available data.

(2) There is considerable uncertainty concerning the accuracy of this 'guesstimate', which is likely to be an overestimate (see text).

Table 11.3

The external costs of carbonated beverage containers in 1977 (plus estimates for 1982) - 1977 prices - marginal cost measure of financial control costs

External Cost Category	Monetised costs 1977 £m. p.a.	(1982) £m. p.a.	Residual (uncontrolled) external impacts
Domestic waste	2.43	(5.4)	Environmental impacts of waste disposal sites
Litter	?	(?)	Visual impacts of littered cans, injuries from littered bottles, broken glass, torn cans and ring pulls
Pollution	?	(?)	See Data in Table 11.1
Hygiene	? (but low)	(?)	No significant hygiene problems
Urban traffic congestion due to on-street beverage deliveries	$<$ 2.3 (1)	(?)	Other environmental impacts of the transportation requirements (e.g. other congestion impacts, road track costs, accidents, noise and vibration)

Source: Chapter 5, table 5.12; chapter 9

(1) There is considerable uncertainty concerning the accuracy of this 'guesstimate', which is likely to be an overestimate (see text).

is particularly marked for the marginal cost based calculations (see table 11.3). Thus, no data were available to enable derivation of any meaningful estimate for the financial control costs of littered beverage containers under this measure. This highlights an important data collection and availability problem attached to the use of the marginal cost measure of external costs.

In tables 11.4 and 11.5, the available monetary estimates have been converted into terms of the unit external costs for the individual returnable and non-returnable containers. This shows that the monetised external costs attributable to an individual returnable bottle, non-returnable bottle[1], bimetallic and aluminium can, under the average cost measure, are between 0.94-1.08 pence[1], 0.8-0.98 pence, 0.33-0.59 pence and 0.28-0.54 pence for each container respectively (1977 prices). These external costs represent about 16 per cent of the costs to the bottler of a new returnable and non-returnable bottle and about 9 per cent of the price of a can.

On account of the lack of data on the marginal cost of controlling litter, it is not possible to derive any aggregate estimate of the financial external control costs of carbonated beverage containers on the basis of the marginal

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(1) These unit external costs for the returnable bottle would be reduced by the re-use of this bottle. It is estimated that the unit external costs per filling of beverage in a returnable bottle with a trippage of 10 would be between 0.21-0.35 pence.

Table 11.4

The unit external costs of the individual returnable and non-returnable containers for carbonated beverages in 1977 in pence per container - 1977 prices - Average cost measure of control costs

External Cost	CONTAINER			
	Returnable Bottle(1) (20 oz.)	Non-returnable Bottle (20 oz.)	Non-returnable Bimetallic can (16 oz.)	Non-returnable Aluminium can (16 Oz.)
Domestic waste	0.81(1) [0.08](1)	0.63	0.15	0.1
Litter - control costs	0.06-0.2	0.12-0.3	0.14-0.4	0.14-0.4
- aesthetic impacts	injuries from littered bottles and broken glass	injuries from littered bottles and broken glass	visual impacts of littered cans, injuries from torn cans & ring pulls	visual impacts of littered cans, injuries from torn cans & ring pulls
Hygiene - control costs	$<$0.0004	? (but v. low)	? (but v. low)	? (but v. low)
- health impacts	no significant impacts	no significant impacts	no significant impacts	no significant impacts
Pollution	?	?	?	?
Urban traffic congestion due to beverage deliveries	$<$0.07(2)	$<$0.05(2)	$<$0.04(2)	$<$0.04(2)
TOTAL	0.94-1.08 [0.21-0.35] + Litter impacts	0.8-0.98 + litter impacts	0.33-0.59 + litter impacts	0.28-0.54 + litter impacts

Source: Tables 5.13, 6.3 and 9.1 and Chapters 6, 8 and 9

(1) These are the unit external costs for an individual returnable bottle. For the returnable bottles, the external waste management costs would be reduced proportionately by the return of a bottle and Table 11.4 also gives in [ ] the appropriate external costs for a returnable bottle with a trippage of 10.

(2) There is considerable uncertainty concerning the accuracy of this very approximate guesstimates which are likely to be an overestimate (see text).

Table 11.5

The unit external costs of the individual returnable and non-returnable containers for carbonated beverages in 1977. In pence per container - 1977 prices - Marginal cost measure of control costs.

External Cost	CONTAINER			
	Returnable Bottle(1) (20 oz)	Non-Returnable Bottle (20 Oz)	Non-Returnable Bimetallic can (16 oz)	Non-Returnable Aluminium can (16 oz)
Domestic waste	0.19 [0.02]	0.15	0.04	0.03
Litter - control costs	?	?	?	?
- aesthetic impacts	injuries from littered bottles and broken glass	injuries from littered bottles and broken glass	visual impacts of littered cans, injuries from torn cans & ring pulls	visual impacts of littered cans, injuries from torn cans & ring pulls
Hygiene - control costs	< 0.0004	? (v. low)	? (v. low)	? (v. low)
- health	no significant impacts	no significant impacts	no significant impacts	no significant impacts
Pollution	?	?	?	?
Urban traffic congestion due to beverage deliveries	<0.07(2)	<0.05(2)	<0.05(2)	<0.05(2)
TOTAL	0.26 [0.09] + litter impacts	0.2 + litter impacts	0.09 + litter impacts	0.08 + litter impacts

Source: Table 5.13 and Chapters 6 and 8

(1) See note (1) Table 11.4.

(2) See note (2) Table 11.4.

cost measure. However, it is expected that the figures under the marginal cost measure would be less than those given above for the average cost measure.

The paucity of the available monetary data also brings out an important merit of the 'best practicable' approach for assessing environmental impacts. Thus, rather than just concentrate solely upon these monetised costs, it is also necessary to take into account any unquantifiable (in monetary terms) but potentially important impacts, in order to obtain a complete measure of the external costs of carbonated beverage containers. Tables 11.2-11.5 identify the existence of such unquantifiable environmental impacts. The previous two sections presented certain physical and qualitative information regarding these impacts.

Of these unquantifiable impacts, the most important appears to be the aesthetic impacts of littered beverage containers, particularly with regard to the visual impacts of bright cans and injuries from broken glass. Data constraints prevented the derivation of a meaningful monetary valuation of these impacts and this represents an important gap in the currently available information. Therefore, this is the area where there is the greatest need for further examination in order to establish an economic valuation of these impacts. Chapter 6 develops a possible methodology for such a study, although it is noted that the performance of sufficient in-depth consumer surveys relating to a representative sample of littered sites would require considerable resources.

Tables 11.1 and 11.6 present the available physical information on the pollution emissions generated by the beverage container systems. The water pollution data are the sum of the total quantities (in tonnes) of water pollutants generated. The different air pollutant emissions have been weighted by their respective ambient air quality standards. This gives a better indicator of the alternative beverage container systems' relative impact in respect of this single item. However, an important limitation of both these weighted figures and the simple aggregated data is that, on their own, they do not provide any guidance concerning the significance of these pollution impacts in comparison with other impact items, such as waste disposal costs and litter. In order to overcome this limitation, monetary valuations of the beverage container systems' pollution impacts should (ideally) be derived by performing all the further stages of the methodology developed in chapter 7. However, this would present a number of practical problems. Moreover the currently available information suggests that pollution emissions from the beverage container systems do not represent a significant portion of the total national pollution load (see Section 11.3.3.(i)). Therefore, it would not be worthwhile to undertake the extensive original research required to derive an accurate economic valuation of these pollution impacts. Chapter 7 then goes on to outline some relevant qualitative information that would be required to supplement the weighted and/or unweighted data on pollution emissions in order to gain a better indication of the significance of these pollution impacts. This additional information concerns certain aspects of the environmental pollution situation at the major plants involved in the beverage container systems. However, the beverage container systems encompass many diverse plants so that even this simplified procedure would entail extensive investigations and would constitute a difficult and costly exercise.

It is the opinion of the Environmental Health Officers that the contaminants in beverage containers do not constitute a hazard to human health and that carbonated beverage containers do not represent a product area of any significant concern. Similarly, the Environmental Health Officers consider that the storage of empty returnables at the retail outlets does not currently present a significant sanitation problem. These findings are substantiated by some approximate 'ball park' estimates which indicate the low order of magnitude of the external costs of investigating complaints about the presence of a contaminant in a returnable bottle (see table 11.4).

It is the opinion of the officials concerned with traffic management and the control of traffic congestion that beverage lorries do not cause significant urban traffic congestion problems. Tables 11.4 and 11.5 also present some very approximate 'ball park' estimates for the congestion costs associated with deliveries to the retail outlets of beverages in returnable and non-returnable containers. Chapter 9 highlights that these estimates have some major limitations. In particular, these estimates were derived from data relating to one high street in a London borough

(Putney), where the congestion impacts are likely to be greater than those arising in an 'average' situation for beverage deliveries. Therefore, the data in Tables 11.4 and 11.5 represent overestimates of these congestion costs. Nevertheless, these upper-level estimates do still indicate the low order of magnitude of the congestion impacts of beverage deliveries. This supports the findings of the review of the authoritative bodies' opinions on this subject.

However, Tables 11.4 and 11.5 indicate that these upper-level estimates for congestion costs are not that much less than the figures for the external waste management and litter costs. Therefore, it might be worthwhile to perform further research in order to obtain a more accurate estimate for these congestion costs and perhaps also to investigate the other environmental impacts of the beverage container systems' transportation requirements (e.g. other congestion impacts, road track costs, accidents, noise and vibration), which it was not feasible to assess in this thesis. Chapter 9 outlines some possible methodologies for the economic evaluation of these congestion and other environmental impacts of the beverage container systems' transportation requirements, although it is noted that it would be difficult to acquire the data and information needed for this.

11.3.4 The environmental impact rankings of returnable and non-returnable containers for carbonated beverages

Table 11.4 indicates that the external waste management and litter control costs of the returnable bottle can be lower than those for the non-returnable systems(2). In addition, it is necessary to take into account the relative aesthetic impacts of littered returnable and non-returnable beverage container systems. Analysis of the carbonated beverage containers found in the litter surveys suggests that the non-returnable bottle and can are likely to be littered more frequently than a returnable bottle(3). Therefore, it is necessary to trade off the (possibly more serious) injury impacts of broken returnable and non-returnable glass bottles against the visual impacts of the probably greater amount of littered cans. The proposed methodology developed in Chapter 6 for the economic evaluation of the external litter costs of the alternative beverage containers could be used to determine this aspect more definitively.

Table 11.6 shows that the returnable system can generate less industrial solid waste, air and water pollution than the non-returnable container systems. Chapters 8 and 9 showed that the use of returnables is likely to create more

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(2) However, as a result of the uncertainties surrounding the available data, a range of values for the litter control costs had to be presented and there is some overlapping between the ranges of these costs for the returnable and non-returnable systems.

(3) However, the limitations of the available data meant that it was not possible to determine with any precision a quantitative estimate for the litter ranking of the various containers.

urban traffic congestion and more hygiene impacts. However, the previous section demonstrated that these hygiene impacts are not significant.

Table 11.4 indicates the congestion costs are not significantly greater for the delivery of beverages in returnable as opposed to non-returnable containers. Efforts were first directed towards ascertaining these specific impacts of the beverage container systems' transport requirements, since it was considered that this was the area where there would be the most significant difference between the impacts of the returnable as compared with the non-returnable systems. Therefore, inclusion of the other omitted impacts should not alter the previous conclusion that the transport-related external costs of the returnable system are not significantly greater than those of the non-returnable systems. This is especially true since some of these other environmental impacts may, in fact, be greater for the non-returnable systems due to the higher transport requirements for the earlier process stages in the non-returnable beverage container systems.

Thus, the available information suggests that that the returnable bottle can create less external costs than the alternative non-returnable container systems, although the picture is not perfectly clear cut, primarily as a result of the current lack of data regarding the aesthetic impacts of litter. In order to determine this subject more definitively, it would be necessary to undertake a thorough economic evaluation of these impacts. A possible methodology for this is developed in this thesis.

Table 11.6

The Domestic and Industrial Solid Waste, Air and Water Pollution Emissions generated by the Distribution of 1000 litres of Beer in the Alternative Container Systems

External Cost	BEVERAGE CONTAINER						
	Returnable Bottle				Non-Returnable Bottle	Can	
	1-trip	5-trip	10-trip	20-trip		Bimetallic	Aluminium
Domestic Waste							
Wgt (Kgs)	1056	211	106	53	704	148	≃ 63
Volume (m^3)	2.85	0.57	0.28	0.14	1.9	1.3	≃ 1.2
Air Pollution (weighted damage(2))							
EPA Study(1) (adjusted)	271.8	84.6	61.2	49.6	230.4	180.5	279.9
Basler & Hoffman Study	n.a	n.a	n.a	76.1	145.8	126.5	-
Water Pollution (kgs)							
EPA Study(1) (adjusted)	6.3	4.04	3.76	3.62	3.87	3.67	7.06
Basler & Hoffman Study	n.a	n.a	n.a	0.87	6.05	14.88	-
Industrial Solid Waste (m^3)							
EPA Study(1) (adjusted)	0.42	0.11	0.07	0.05	0.29	0.61	0.27

Source: US EPA (1974), Basler and Hoffman (1974)
Tables 5.9, 7.2 and 7.9, Chapters 5 and 7

(1) The data in the EPA study have been adjusted to allow for the major differences between the container systems analysed in this study and the current position in the U.K. (e.g., with respect to supplementary paper packaging required). The remaining differences between the two studies' absolute figures for pollution emissions are primarily due to the different methodologies and assumptions adopted in these separate studies. A more detailed discussion of these pollution impact studies is given in Chapter 7.

(2) The quantities (in Kgs.) of each air pollutant have been weighted by the ambient air quality standards to give a measure of the relative air pollution damage caused by the alternative container systems.

However, It is evident from table 11.6, that this favourable environmental ranking of the returnable bottle depends essentially upon the trippage achieved by this bottle. Table 11.7 shows the break-even trippages that the returnable has to achieve in order to generate less domestic and industrial solid waste, air and water pollution than the various non-returnable container systems. The important externality, litter, will also be affected by the trippage of the returnable bottle, since the littering of a returnable bottle is one of the possible leakages of the returnable system that could prevent the bottle from being used again. Thus, measures to increase the trippage of the returnable bottle could also result in less littering of returnable bottles.

11.3.5 The external costs generated by carbonated beverage containers under different scenarios for 1982

Table 11.8 summarises the estimates of the external costs generated by the container systems for carbonated beverages in the U.K. under eight different scenarios for 1982. The marginal cost measure of waste management costs has been used to show the level of any savings (or increases) in waste management costs that would result under the various (policy induced) scenarios. Comparison of the different external cost levels and the principal features of the various scenarios, presented in table 11.9, yields a number of interesting conclusions.

The results for scenario III show the increase in the external costs of carbonated beverage containers that would occur if the current trends of an increased use of

Table 11.7

Break-even trippages for the returnable bottle to generate less domestic and industrial solid waste, air and water pollution than the non-returnable container systems.

External Cost	Non-returnable container		
	Non-returnable glass bottle	Bimetallic can	Aluminium can
Domestic Waste - weight	1.5	7-9	17-20
- volume	1.5	2-3	2-3
Industrial solid waste	1.5	0.7	1.6
Air pollution damage	1.2	1.6	1.0
Water pollution	7.2	14.8	0.8

Source: US EPA (1974), Tables 5.9, 5.10 and 7.11

Table 11.8

The external costs generated annually by the container systems for off premise sales of carbonated beverages in the U.K. under the different scenarios II - IX for 1982 (1977 prices)

SCENARIO	EXTERNAL COSTS: Domestic Waste Management Costs (MC measure)(2)	cfn with Scenario II		Industrial Solid Waste	cfn with Scenario II		Air Pollution	cfn with Scenario II		Water Pollution	cfn with Scenario II		Litter(3)	Hygiene(3)	Urban(3) Traffic Congestion
	£000s	£000s	%	'000s m^3	'000s m^3	%	Weighted Damage 10^6 units	Weighted Damage 10^6 units	%	'000s tonnes	'000s tonnes	%			
II	5361	-	-	997	-	-	483			11.3	-	-	Littered bottles, cans, ring pulls & tops	No significant problems	
III	7137	+1776	+33%	1120	+123	+12%	563	+80	+17%	11.0	-0.3	-3%	More littered bottles and cans	No significant problems	
IV	4787	-574	-11%	893	-104	-10%	439	-44	- 9%	11.2	-0.2	-2%	Slightly less littered bottles & cans	No significant problems	
V	3922	-1439	-27%	679	-318	-32%	356	-127	-26%	10.7	-0.6	-5%	Less littered bottles and cans	No significant problems	
VI	5310	-51	-1%	773	-225	-23%	413	-70	-14%	11.4	+0.1	+1%	Less littered cans & slightly less littered bottles	No significant problems	
VII	2039	-3322	-62%	617	-381	-38%	295	-188	-39%	10.5	-0.8	-7%	A significant reduction in littered bottles and cans	Perhaps sanitation problems at some retail outlets	No significant problems
VIII	1575	-3786	-71%	182	-816	82%	160	-323	-67%	9.8	-1.5	-13%	A significant reduction in littered bottles & cans	Some sanitation problems at some retail outlets	No significant problems
IX	1050	-4311	-80%	148	-849	-85%	140	-342	-71%	9.6	-1.8	-16%			

Source: Tables 5.14 and 7.12, Chapters 6, 8 and 9

(1) All the scenarios II-IX do not allow for any possible reductions in the weights of returnable and non-returnable containers nor any possible reduction in pollution emission coefficients between 1977 and 1982.
(2) The marginal cost measure of waste management has been used to show the changes in the financial costs of domestic waste management that would arise under the different scenarios.
(3) The information given for scenarios III-IX refers to the relative levels in comparison with the situation depicted for the base line scenario II.

Table 11.9

The principal features of the different scenarios II-IX

	SCENARIOS	'Off' Premise Market Share (by vol.) of beer, cider and carbonated soft drinks sales				'Off' Premise Trippage
		Non-Returnable			Returnable	
		Glass bottle	Bimetallic can	Aluminium can	Glass bottle	
II	NO ACTION FORECASTS	19.5%	40%	12.5%	28%	3
III	100% non-returnables	43%	43.5%	13.5%	0%	n.a.
IV	Market shares and trippage at 1977 levels	16%	35%	11%	38%	4
V	RB's market share x 2 trippage x 2	12%	25%	8%	56%	6
VI	RB's market share x 2 but no increase in trippage	12%	25%	8%	56%	3
VII	Post-mandatory deposits situation	0%	27%	9%	64%	10
VIII	100% RB	0%	0%	0%	100%	10
IX	100% RB - higher trippage	0%	0%	0%	100%	15

RB = Returnable bottle

non-returnables continue to the extreme case of there being a complete demise of the returnable system. However, this completely non-returnable scenario III generates a lower level of external costs for one category - water pollution emissions - than the base line scenario II. This is due to the decline in the trippage of the returnable bottle that is predicted to occur by 1982 under the NO ACTION scenario II. At this low trippage, of 3, the returnable system generates more water pollution than the non-returnable container systems. It is also evident, from table 11.8, that water pollution emissions rise under scenario VI where the market share of the returnable bottle rises, but the trippage fails to increase.

The importance of achieving increases in the returnable's trippage is further demonstrated through a comparison of the results for the two scenarios V and VI which both depict an intermediate increase in the market share of the returnable bottle. Thus, the higher trippage scenario V yields a 27 per cent reduction in the waste management costs of carbonated beverage containers while the lower trippage scenario VI yields only a 1 per cent reduction. Scenarios VII, VIII and IX also demonstrate the savings in the external costs of carbonated beverage containers that could result from increases in the market share and trippage of returnable bottles.

Scenario VII illustrates the situation after the implementation of mandatory deposit legislation. This was the beverage container policy proposed by Friends of the Earth in their minority report to the Waste Management

Advisory Council [Cawdell (1980)]. Table 11.8 shows that such mandatory deposit legislation would result in a 62 per cent reduction in the waste management costs of carbonated beverage containers. This is equivalent to an annual saving in waste management costs of about £3.32m. in 1982 (at 1977 prices), which represents about 0.7 per cent of the U.K. authorities' total costs of collecting and disposing of domestic waste. Table 11.8 also demonstrates that, under this mandatory deposit scenario VII, the annual level of industrial solid waste, air and water pollution generated by the carbonated beverage container systems would be reduced by 38 per cent, 39 per cent and 7 per cent, respectively. Chapter 7 develops a possible methodology for evaluating the significance of these reductions in pollution emissions. The levying of mandatory deposits is designed to penalise the individual 'litterer' who forgoes the deposit he has paid on a container if he litters this container. In addition, mandatory deposit legislation could facilitate and encourage the actions of scavengers picking up the littered containers and returning them for the redemption of their deposit value. Therefore, mandatory deposit legislation could be expected to result in a significant reduction in the number of littered cans and bottles.

It is the view of the traffic control authorities that an increased use of returnables would not create any significant urban traffic congestion problems. The Environmental Health Officers have also stated that an increased use of returnables would not present any significant contamination problems. However, they also suggested that some sanitation problems might arise at certain retail outlets lacking storage space if there was a marked shift in the beverage market, as exemplified in the completely returnable systems depicted in scenarios VIII and IX and perhaps also under the mandatory deposit scenario VII.

11.4 Policy implications

The previous section 11.3 and chapters 5, 6, 7, 8 and 9 of this thesis have provided some empirical and qualitative information which could aid the determination of whether the government should consider intervening in the beverage container market.

On account of the impossibility of obtaining all the necessary information, this thesis did not set out to select and formulate the optimum policy for the beverage container issue. However, in chapter 4, a framework of criteria for the evaluation of the alternative beverage container policy measures has been provided. It is also possible to formulate a number of observations from this framework and the empirical analyses presented in this thesis.

The information given in table 11.8 could form a useful input for an evaluation of beverage container policy measures. In order to perform a full policy evaluation, it would be necessary to analyse the other factors identified in the framework (e.g., the impacts of the alternative policy measures on energy and raw materials consumption, consumer sovereignty and choice, and the economic impacts of the policies). In this respect, it is important to note that table 11.8 shows the annual level of environmental benefits that would be generated, not just in one period but also in future periods, by increases in the use and re-use of returnables. In contrast, many of the adverse economic impacts of such a policy measure would be once and for all impacts (e.g., obsolescence of non-returnable filling lines, additional investment at the distribution and retailing stages, etc.). Furthermore, the size of the annual environmental benefits could be expected to increase over time as waste management costs continue to increase in real terms.

Tables 11.1-11.3 and 11.8 highlight the increase in the environmental impacts of carbonated beverage containers that will occur in 1982 if there is a continuation in the recent trends of a decline in the market share and trippage of the returnable bottle. The results for scenario IV in table 11.8 show the environmental benefits that could be obtained by preventing any further decline in the position of the returnable. Under scenario IV, the sales level of beverages in non-returnables would not decrease, but would continue to rise. This means that such a policy measure would not create adverse economic impacts such as the obsolescence of capital equipment, redundancies, etc. This suggests that it would be beneficial to prevent any further decline in the position of the returnable.

It is evident that the trippage achieved by the returnable bottle plays an important role in determining the viability of the returnable system. Furthermore, the results for scenarios V, VII, VIII and IX in table 11.8 indicate that increases in the returnable's market share and trippage would yield reductions in the environmental impacts of carbonated beverage containers.

This aspect was rigorously examined in chapter 10 of this thesis. Chapter 10 demonstrated that the trippages of returnable beer, cider and soft drinks bottles in the U.K. are much lower than those currently achieved in all other countries. Opinion Surveys of 1,528 householders and school children in Leicester, Blackburn and Colwyn Bay show that many consumers do not return bottles because they experience difficulties in returning bottles. These difficulties arise from two major sources. First, an apparent lack of knowledge that the bottle is a returnable with a refundable deposit on it. Thus, of those consumers who did not return a 'returnable' bottle, 22 per cent thought that this bottle was a non-returnable and a further 14 per cent did not know whether this bottle was a returnable or non-returnable. The second and most frequently mentioned source was the problems that the consumers encounter in finding a retailer willing to accept their returnable bottles. Many consumers said that a retailer had refused to accept a returnable bottle they had taken to a shop. This finding was substantiated by the results of a bottle returning exercise that was performed in Leicester. The retailers rejected 5-6 out of each set of 8 randomly selected returnable bottles that were taken to 24 shops in this exercise. In addition, a separate questionnaire survey of the opinions and practices of 69 retailers in Leicester and Blackburn ascertained that most retailers place restrictions on the types of returnable bottles they will accept, in order to reduce the number of returned bottles (and their concomitant problems) that they have to handle.

Similarly, these surveys provide an explanation for the ineffectiveness of raising deposit levels, which is the method that has traditionally been adopted in an attempt to halt the decline in the trippage rates. The consumer surveys found that over 80 per cent of those consumers, who did not return a bottle, either did not know what the deposit level was or thought that it was less than its present level.

Thus, it appears that the reasons for the British consumers' apparently widespread failure to return bottles are more complex than the conventional wisdom diagnosis that consumers "just cannot be bothered to return bottles". Furthermore, the surveys indicate that, rather than just accept the low and declining trippage rates in the U.K. as being irremediable, there are some positive measures that could reverse these trends and could raise trippage rates.

The deposit is supposed to act as an incentive and to compensate the consumer for the inconvenience of returning bottles. Therefore, rather than just raise the deposit levels, it would be more effective to reduce the inconvenience of returning bottles. There are two major ways of making it easier for consumers to return bottles. The first is the provision of some clearer information that the bottle is returnable, with refundable deposit. This information could be displayed at the retail outlet and on the bottle (either on the bottle's label or top or embossed into the actual bottle). The second is an increased acceptance of returned bottles by the retailers. This could conceivably be achieved through a voluntary agreement between the government, bottlers and the retailers. Alternatively, if this proved ineffective, it might be necessary to introduce regulations requiring retailers to accept empty returnable bottles from consumers for the redemption of the appropriate deposit. However, the retailers could only be expected to accept bottles that could be re-used by their suppliers and the regulations would have to be formulated accordingly. Such regulations might prove difficult to enforce. A possible incentive measure would be the payment of a handling charge to the retailer by the bottler for each bottle returned. The implementation of one or more variants of the above measures would ease the major difficulty that is currently experienced by British consumers in returning (or rather attempting to return) bottles.

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Chapter 11

Conclusions

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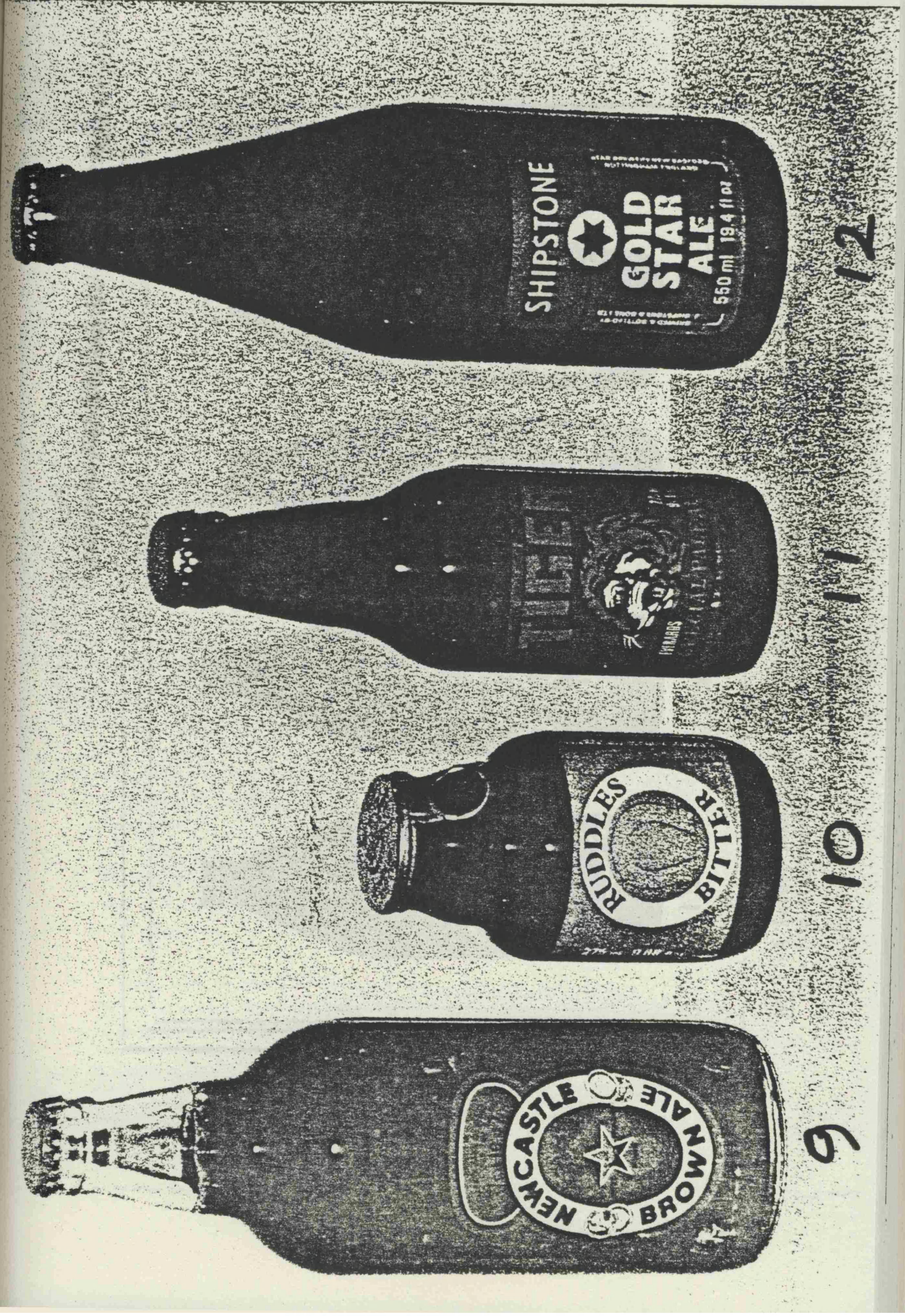
Photographs used for
the Consumer Surveys in
Leicester

SOFT DRINK BOTTLES - CARD A

SOFT DRINK BOTTLES - CARD B

BEER BOTTLES - CARD C



CIDER BOTTLES - CARD D

NB : A larger photograph (10" x 8") than that shown here was in fact used for the survey.

The Questions relating to Carbonated Beverage Containers in the Household Questionnaire used in the Consumer Survey in Blackburn

BLACKBURN WASTE SURVEY

NORTH WEST WASTE RECLAMATION COMMITTEE

MANCHESTER BUSINESS SCHOOL

(Manchester University)

Questionnaire Number __________

Time started __________

Interviewer __________

I am from Blackburn Waste Survey/the Town Hall. My name is .... You may have heard about the survey on Radio Blackburn, and I left a leaflet like this (show) a few days ago. We would be very grateful if you would agree to be interviewed.

1. Your house has been chosen as part of a cross-section of the population of Blackburn, so it's quite important that you should be included.

2. However, you will remain anonymous in the results of the survey - your name will not be used. The results will be in the form of statistics.

3. We would like to emphasise that there are no right or wrong answers to the questions. Different people have different ideas, and we are interested in what you think.

Source: BLACKBURN Waste Survey: A study of public attitudes to household waste collection and disposal. Mercer, D., Ng, M., Lowther, C., Chapman, J. (1980). Profit from Waste Ltd., Manchester Business School, Manchester, 1980.

FAMILY BACKGROUND

The first few questions are about the family. We ask these so that we can put you into groups, large and small families and so on, and see whether the different groups give different answers.

1. How many people are in the family? ....
   Enter total.

2. How many of them are

aged 16 or under	....
aged 17 to 30	....
aged 31 to 50	....
aged 51 to 60	....
aged over 60	....

3. Which of these age-groups are you yourself in? ....

4. How many of the family are working? ....
   (Check - That's yourself, your husband etc.)
   List all workers.

5. What job does (main wage-earner) do? ....

6. Houses only

   Do you own or rent this house?

own	....
rent	....

7. If rented

   Is it owned by the council or a private landlord?

council	....
private	....

Now we would like to talk about other kinds of drinks that you may buy.

24. Do you or anyone in the family buy any soft drinks to bring home? Which ones?
List drinks below in table.

IF BUYS NONE GO TO 26

25. Are they usually in returnable bottles, non-returnable bottles, or cans?
Tick for each drink.

	Returnable	Non-returnable	Cans
1.			
2.			
3.			
4.			
5.			
6.			

26. Can you tell me whether these bottles are returnable, non-returnable or you don't know?
Show card A.

Returnable = ✓
Non-returnable = X
Don't know = ?

Bottle 1	
2	
3	
4	
5	
6	

SOFT DRINKS

27. How often do you buy any of these particular bottles? Show card A. Tick for each bottle.

	never	rarely	occasionally	often
Bottle 1				
2R				
3				
4R				
5				
6R				

IF BUYS NO SOFT DRINKS GO TO 29

28. Of the returnable bottles that you buy, how many do you actually return? Tick for each bottle.

	All	Most	Some, a few	None	Don't know
Bottles on card A. 2					
4					
6					
Other returnables (see 25) Name -					
Name -					
Name -					

BEER AND CIDER

→29. Do you or anyone in the family buy any beer or cider to bring home? Which brands?
List drinks below in table.

IF BUYS NONE GO TO 31

30. Are they usually in returnable bottles, non-returnable bottles, or cans?
Tick for each drink.

	Returnable	Non-returnable	Cans
1.			
2.			
3.			
4.			
5.			
6.			

→31. Can you tell me whether these bottles are returnable, non-returnable or you don't know?
Show cards B and C.

Returnable = ✓
Non-returnable = X
Don't know = ?

Beer bottle	1	
	2	
	3	
	4	
Cider bottle	1	
	2	
	3	
	4	

IF BUYS NO DRINKS AT ALL, GO TO 51
IF BUYS ONLY SOFT DRINKS, GO TO 34

BEER AND CIDER

32. How often do you buy any of these particular bottles?
Show cards B and C.
Tick for each bottle.

	never	rarely	occasionally	often
Beer bottle 1 R				
2				
3 R				
4 R				
Cider bottle 1 R				
2 R				
3				
4 R				

33. Of the returnable bottles that you buy, how many do you actually return?
Tick for each bottle.

	All	Most	Some, a few	None	Don't know
Bottles on card B 1					
3					
4					
card C					
1					
2					
4					
Other returnables (see 3D) Name -					
Name -					
Name -					
Name -					

RETURN OF BOTTLES

34. If returns bottles

What is your main reason for returning bottles?

35. If doesn't return all returnables

Is there any particular reason why you don't return (some) bottles?

36. What would encourage you to return more bottles?

37. How easy or difficult is it for you to return bottles to the shops? Is it easy/difficult for all of them? Write in brands which are easy and difficult.

very difficult ....
a little difficult ....
fairly easy ....
very easy ....
other (write in) ....

38. What makes it easy/difficult (see 37) to return them to the shops?

39. Have you found any shop unwilling to accept them? Which one?
Enter name and type of shop.

yes ....
no ....

40. **If yes**
Why were they unwilling?

41. Did you give up then, or return the bottles somewhere else?

gave up	....
returned elsewhere	....

42. Do you know the deposit on these returnable bottles?
Enter deposit quoted.

soft drinks	2	....
	4	....
	6	....
beer	1	....
	3	....
	4	....
cider	1	....
	2	....
	4	....

43. What deposit would make it just worthwhile for you to return bottles - the minimum that you would return them for?

....

44. On the whole do you prefer drinks in glass bottles, plastic bottles, or cans?
Tick.

glass bottles	....
plastic bottles	....
cans	....
any of them	....

45. **If states a preference**
Why do you like them best?

46. **If states a preference**
What do you dislike about the other two containers?

glass bottles	....
plastic bottles	....
cans	....

47. Do you think returnable or non-returnable bottles are best?
Tick.

returnable	....
non-returnable	....
either	....

48. **If states a preference**
Why do you think that?

49. Where do you usually buy your drinks?

soft drinks at	....
beer at	....
cider at	....

50. Where do you do your main shopping

ENVIRONMENTAL ATTITUDES

69. If these bins were used, and waste was separated for recycling, do you think it would:

	Yes	No	D.K.
help to keep the price of goods down?			
save on materials from which goods are made?			
save fuel used in manufacturing goods?			
save land from being used for tipping?			

70. Do you think it would:

	Yes	No	D.K.
result in poorer quality goods?			
lead to unemployment?			

71. Would it be:

	Yes	No	D.K.
too much trouble for householders to do it?			
too difficult or costly for the council to run the scheme?			

72. Do you think it would:

	Yes	No	D.K.
benefit the population as a whole?			
be of benefit to you and your family?			

73. Would you please say whether you think the following statements are True or False.

	True	False	D.K.
Many goods have too much wrapping.			
A lot of good clothes are thrown away.			
People should cut down on the petrol & oil they use.			
A lot of food is wasted in this country.			
The countryside is being spoiled in many places.			
Towns and cities are too noisy these days.			
Cities are taking up too much space.			
People don't care about keeping Britain tidy.			

74. **Asian interviewees**

How long have you been in this country?

No. of years ....

75. **Asian interviewees**

How well do you speak English?

fluently ....

a little ....

not at all ....

76. Had you heard about the survey, either on Radio Blackburn or in the newspaper (before you received our letter)?
Tick if Yes.

radio ....

newspaper ....

Thank you very much for your help. It has been most interesting to talk to you. We hope that the results of the study will be useful to the Blackburn Borough Council and to the Government, in trying to deal with the problem of waste. If you are interested in knowing what comes out of the survey, the results will be ready at the end of the year, and will be announced in the newspapers and on Radio Blackburn.

(Hand out copy of 'Thank You' leaflet).

Interest in the problem: Interested ....

Indifferent, can't tell ....

Antagonistic ....

Time finished..................

Length of interview .... minutes

Type of housing ....

Members of family interviewed:

Wife/single woman ....

Husband/single man ....

Photographs used for the

Consumer Survey in Blackburn.

SOFT DRINKS BOTTLES

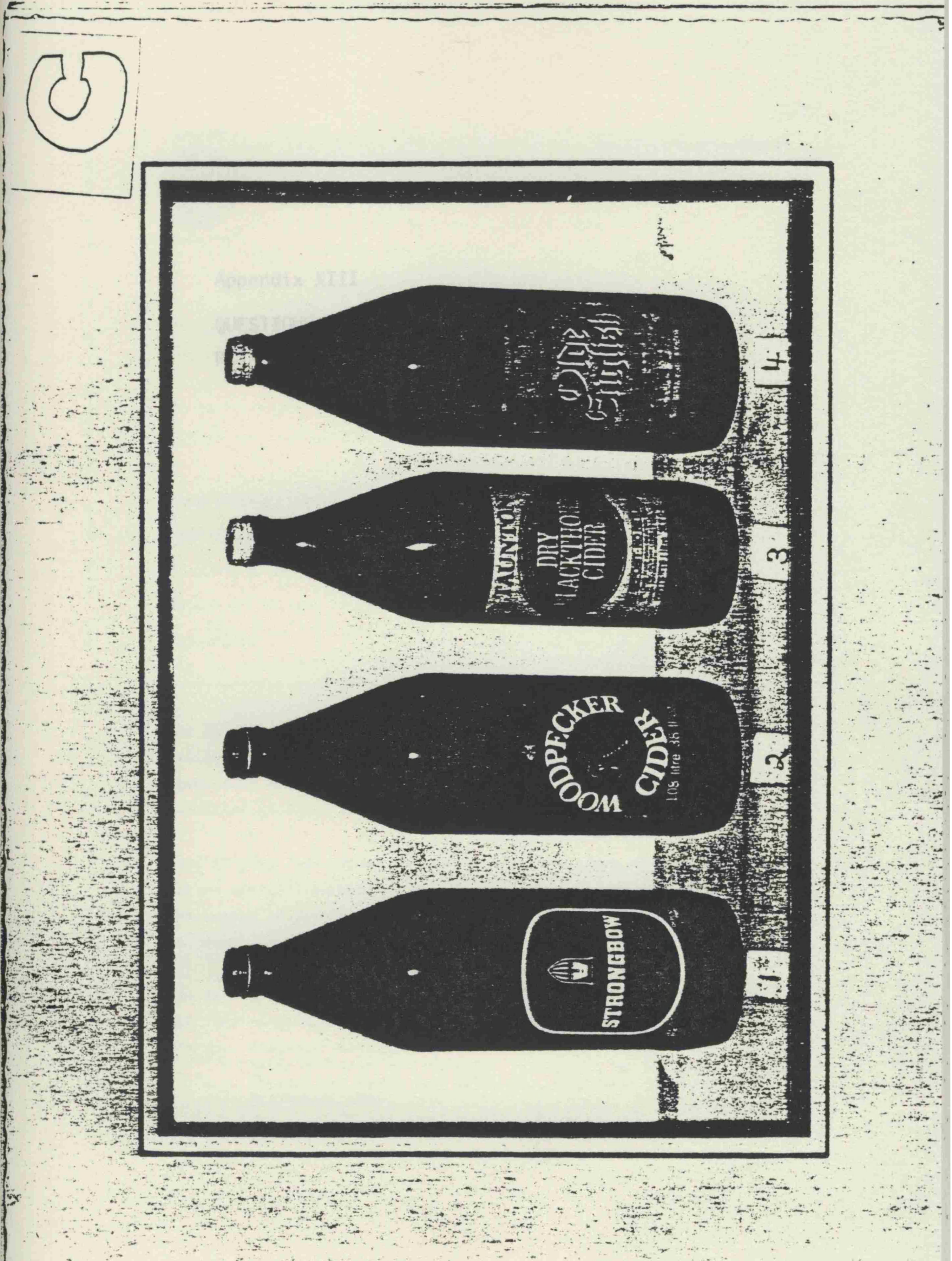
CARD A

BEER BOTTLES

CARD B

CIDER BOTTLES

CARD C



Appendix XIII

QUESTIONNAIRE USED FOR THE RETAILERS SURVEY

BLACKBURN WASTE SURVEY

Retailer Questionnaire
Blackburn 27-09-79.
Not for publication.

NORTH WEST WASTE RECLAMATION COMMITTEE

MANCHESTER BUSINESS SCHOOL

(Manchester University)

Questionnaire Number ....

Type of retail outlet ....

Position of respondent ....

Date ....

Interviewer ....

The Blackburn Waste Survey (conducted by researchers from Manchester and Leicester universities) is concerned with various aspects of the management of waste collection and disposal. Both householders and retailers are being asked to participate by answering questionnaires.

Your shop has been chosen as part of a cross-section of the retail outlets in and around Blackburn which sell soft drinks and alcoholic beverages. One aspect of the survey is concerned with the containers in which these products are sold.

The information given by all participants will be treated as confidential, and your co-operation will be greatly valued by the researchers.

Source: Blackburn Waste Survey: A study of public attitudes to household waste collection and disposal. Mercer, D., Ng, M., Lowther, C., Chapman, J., Profit from Waste Ltd., Manchester Business School, Manchester, 1980.

We should be very grateful if you would answer the following questions in as much detail as possible. They are concerned with the various types of container in which beverages are sold, and are designed to throw light on some of the problems connected with the use of returnable and non-returnable containers. Our interviewer will assist you if necessary.

If you sell soft drinks in bottles, please answer section A. (question 1-2).
If you sell beer in bottles, please answer section B. (question 3-4).
If you sell cider in bottles, please answer section C. (question 5-6).
If you sell any beverages in cans, please answer section D. (question 7-9).
Please also answer the relevant part of section E.

A. Soft drinks

(These include coke, lemonade, etc., lucozade, tonic water, bitter lemon, Britvic and other pure fruit juices; not squashes).

1. Could you please give the approximate size of your order last month for the soft drinks listed above.

   Please divide them into the following categories:

   RETURNABLE BOTTLES .... doz.

   NON-RETURNABLE BOTTLES .... doz.

   CANS .... doz.

2a What sizes of returnable soft drinks bottles do you sell?

b What proportion of the returnable soft drinks bottles are returned to you?

4 to 7 oz ....
26 oz ....
litre or quart ....

B. Beer

(This includes lagers).

3. Please give the approximate size of your order last month for beers and lagers.

   Please divide them into the following categories:

   RETURNABLE BOTTLES .... doz.

   NON-RETURNABLE BOTTLES .... doz.

   CANS .... doz.

4a What sizes of returnable beer & lager bottles do you sell?

b What proportion of the returnable beer bottles are returned to you?

6 oz	....
½ pint	....
1 pint	....
2 pints	....

C. Cider

5. Please give the approximate size of your order last month for cider.
   Please divide it into the following categories:

   Returnable bottles .... doz.
   Non-returnable bottles .... doz.

6. What proportion of the returnable cider bottles are returned to you?

   ....

D. Aluminium Cans

7. Are any of the cans you handle all-aluminium?

yes ....
no ....
don't know ....

8. If yes, what proportion are all-aluminium?

....

9. Which products are in all-aluminium cans?

10. If there was a deposit and return system for aluminium cans (as for bottles) how would you feel about this?

E. Retailers Policy and Opinion on Returnable Bottles

IF YOU DO NOT SELL RETURNABLE BOTTLES, PLEASE GO TO QUESTION 20.

11. In marking the prices of returnable bottles (either on your shelves or on the bottles) which of the following do you do? If you use more than one method, please say which drinks you use each method for.

a) Mark the price including beverage and deposit (if the price of a pint of beer is 30p and the deposit 6p you would mark it 36p). ....

b) Mark the price of the beverage only excluding the deposit. (For the pint of beer this would be 30p). ....

c) Mark the price of the beverage and the deposit separately. (For the beer this would be 30p + 6p deposit). ....

d) Mark the price including the beverage and the deposit, but say that a deposit is included. (For the beer this would be 36p (incl. 6p deposit). ....

e) The deposit alone is on the bottle. ....

f) Neither price nor deposit is marked. ....

g) Any other price marking system (please give details) ....

12. When a customer buys a returnable beer, cider or soft drink bottle, do you tell him about the deposit on the bottle:

never	....
occasionally	....
frequently	....
always	....

13. How do you feel about handling returnable bottles and redeeming the deposits?

14. If you sell beverages in returnable bottles, does this cause you any problems or inconvenience?

yes ....
no ....

<u>If yes</u>, please describe the problems or inconvenience.

<u>If yes</u>, would you say the problem or inconvenience is

slight ....
moderate ....
severe ....

15. Do you accept all returnable beer, cider and soft drinks bottles that are brought back to your shop or only certain ones?

all ....
certain ones ....

16. Please say which beer, cider and soft drinls bottles you do accept.

(<u>Probe to find whether 'those I sell' means</u>:
specific bottles sold - with retailer's stamp?
bottles he thinks he sold - from his own customers?
any bottles of brands he sells?
bottles of standard shape/size?)

17. Would you ever <u>not accept</u> one of those bottles (the ones you normally do accept? <u>Repeat categories described above</u>.) In what circumstances?

18. Now to come to the bottles you don't accept (<u>mention the categories not described in 16</u>), why is it that you can't or don't take them?

(<u>If 'supplier doesn't accept', probe to find:</u>
a) which supplier - cash & carry, wholesaler, bottler/brewer?
b) whether they accept - only their own labelled bottles?
- bottles of standard shape/size?)

19. Where do you store returned bottles?
(AFTER ANSWERING THIS QUESTION PLEASE CONTINUE WITH QUESTION 21)

20. Could you please give the reasons why you do not handle returnable bottles?

21. If returnable bottles were to be used more widely than now, what would your attitude be?

22. Did you know that the National Association of Soft Drinks Manufacturers has recommended the use of symbols like the ones below on the labels of returnable and non-returnable containers?

Symbol for returnable bottles:

yes ....
no ....

Symbol for non-returnable containers:

yes ....
no ....

23. Have you actually seen either of the following symbols which are now in use on some bottles and cans?

Symbol for returnable bottles:

yes ....
no ....

Symbol for non-returnable containers:

yes ....
no ....

24. Do you think the symbols will:

	yes	no
Increase the number of bottles returned?		
Reduce the litter caused by bottles and cans?		

Can you suggest any way of improving the symbols?

25. Please say which days of the week and what times you are open.

26. Is this shop a member of a 'symbol' group - e.g. M.A.C.E., BOB, V.G., etc?

27. Could you please list below the suppliers from whom you obtain your soft drinks, beers and ciders.

wholesalers	....
	....
	....
cash-and-carry warehouses	....
	....
	....
manufacturers (direct supply)	....
	....
	....
any other suppliers	....
	....
	....

Thank you very much for your co-operation. The questionnaire will be collected from you. The results will be compiled at Manchester and Leicester Universities.

Appendix XIV

Details of the Returnable Bottles used in the Bottle Return Exercise

(A) Soft Drinks

BRAND	Size	Deposit	Shape	No. of Times Rejected	No. of Times Accepted	Deposit Correct	Given Under
Coke	26 oz	8p	Dist.	-	5	3	2
	$6\frac{1}{2}$oz	4p	Dist.	8	1	1	-
Pepsi	$6\frac{1}{2}$oz	4p	Dist.	1	-	-	-
Lovetts	38 oz	8p	Std.	3	2	2	-
"	35 oz	8p	Std.	-	2	1	1
"	26 oz	8p	Std.	8	5	3	2
" (Cordial)	26 oz	8p	Std.	2	-	-	-
Furnivals	38 oz	8p	Std.	1	1	1	-
Hoyes	38 oz	8p	Std.	-	1	1	-
Corona	35 oz	8p	Dist.	11	1	1	-
" (Cordial)	26 oz	5p	Dist.	1	-	-	-
Carters	35 oz	8p	Dist.	4	-	-	-
C & R	35 oz	7p	Dist.	3	-	-	-
Lilt	26 oz	8p	Dist.	2	-	-	-
Schofields	38 oz	8p	Std.	4	-	-	-
Britvic Orange Juice	4 oz	4p	Std.	4	1	1	-
Rawlings Tomato "	4 oz	4p	Dist.	1	-	-	-
Schweppes	6 oz	4p	Std.	1	-	-	-
"	4 oz	4p	Std.	3	2	1	1
Canada Dry	4 oz	4p	Dist.	3	-	-	-
Unlabelled	6 oz	4p	Std.	1	-	-	-
Total Standard (Std.) Bottles				27	14	10	4
Total Distinctive (Dist.) Bottles				34	7	5	2
Total Soft Drinks				61	21	15	6

(B) Cider

BRAND	Size	Deposit	Shape	No. of Times Rejected	No. of Times Accepted	Deposit Correct	Given Under
Olde English	38 oz	10p	Std.	3	3	3	-
Woodpecker	38 oz	10p	Std.	2	3	3	-
Strongbow	38 oz	10p	Std.	2	3	3	-
Coates	38 oz	10p	Std.	1	1	-	-
Total Cider Bottles (all standard)				8	10	9	1

(C) Beer

BRAND	Size	Deposit	Shape	No. of Times Rejected	No. of Times Accepted	Deposit Correct	Given Under
Newcastle Brown	1 pt	6p	Dist.	9	6	5	1
M & B	1 pt	6p	Std.	1	2	2	-
Kimberley	1 pt	6p	Std.	5	2	2	-
Thwaites	1 pt	6p	Std.	7	-	-	-
Manns	1 pt	6p	Std.	4	2	2	-
Shipstones	1 pt	6p	Std.	1	6	6	-
Everards	1 pt	6p	Std.	2	-	-	-
"	½ pt	4p	Std.	4	1	1	-
Skol	½ pt	4p	Std.	7	3	2	1
Carlsberg	½ pt	4p	Std.	1	1	1	-
Bass	½ pt	4p	Std.	1	-	-	-
Marstons	½ pt	4p	Std.	1	1	1	-
Belgium pils	½ pt	4p	Dist.	10	-	-	-
Guiness (local bottler)	1 pt	6p	Std.	-	3	3	-
" " "	½ pt	4p	Std.	1	1	-	1
Guiness (distant bottler)	1 pt	6p	Std.	3	2	2	-
Unlabelled	1 pt	6p	Std.	4	1	1	-
Total Standard bottles				42	25	23	2
Total Distinctive bottles				19	6	5	1
Total Beer bottles				61	31	28	3

Appendix XV

List of government agencies, private companies and other organisations who provided information for this report

The following are the major organisations, companies and government departments who provided information for this research report. I am most grateful to the many people in these organisations for their valuable assistance.

CENTRAL government Departments and Agencies

Association of District Councils
Alkali and Clean air Inspectorate
Central Electricity Generating Board (CEGB)
Central Unit on Environmental Pollution (CUEP) of DOE
Countryside Commission
Department of the Environment (DOE)
Department of Health and Social Security (DHSS)
Department of Industry (DOI)
Environmental Health Officers Association (EHA)
Forestry Commission
Harwell, Waste Research Unit
Local Government Operations Research Unit
Ministry of Agriculture, Fisheries and Food (MAFF)
National Anti-Waste Programme
National Coal Board - Coal Research Establishment
National Park Authorities :-

- Brecon Beacons National Park
- Lake District National Park
- North Yorkshire Moors National Park
- Peak District National Park
- Pembrokeshire Coast National Park
- Snowdonia National Park

Scottish Development Department
Transport and Road Research Laboratory (TRRL)
Warren Spring Laboratory
Water Data Unit of DOE
Water Authorities :-

- Severn Trent Water Authority
- South West Water Authority
- Thames Water Authority
- Welsh Water Authority
- Wessex Water Authority

Local Authorities

Berkshire County Council
Cambridgeshire County Council
Cleveland County Council
Cornwall County Council
Dundee City Council
Durham County Council
Essex County Council
Falkirk District Council
Glasgow District Council
Greater London Council
Hampshire County Council
Leeds City Council, Department of Environmental Health
Leicester City Council
Leicestershire County Council

Liverpool City Council
London Borough of Hillingdon
Merseyside County Council
Northamptonshire County Council
Nottinghamshire County Council
Oxfordshire County Council
Roxburgh District Council
Suffolk County Council
Tyne and Wear County Council
West Sussex County Council
West Yorkshire Metropolitan County Council
South Yorkshire County Council

Brewers

The Brewers' society
Institute of Brewing
Everards Ltd.
Fullers Ltd.
Marstons Ltd.
G. Ruddle & Co. Ltd.
Watneys Ltd.
Whitbread & Co. Ltd.

Soft Drinks Bottlers

British Soft Drinks Council
A. G. Barr & Co. Ltd.
Beechams Foods Ltd.
N. Furnival & Co. Ltd.,
Schweppes Ltd.
Wright Drinks Ltd.

Other Private Companies and Organisations

Anglesey Aluminium Metal Ltd.
Atkins Research and Development
British Petroleum Co. Ltd.,
British Steel Corporation
The Chartered Institute of Public Finance and Accountancy
Confederation of British Industry
England, Grosse and Associates Ltd.
Fine Fare Ltd.
Friends of the Earth
Gateway Food Markets Ltd.
Glass Manufacturers Federation
Industry Committee for Packaging and the Environment (INCPEN)
Institute of Grocery Distribution
Institute of Solid Wastes Management
Dr. L. Katan, Consultant, Polymers Safety and the Environment
Keep Britain Tidy Group
Keep Wales Tidy
Material Recovery Ltd
Metal Box Ltd
Multiple Food and Drink Retailers Association
National Farmers' Union
Peat, Marwick and Mitchell, Consultants, Paris
PIRA
Redfearn National glass
Retail Consortium
Royal Society for the Prevention of Accidents
Royal Society for the Prevention of Cruelty to Animals
SPD Distribution Ltd.
United Glass Containers Ltd.

Universities and Educational Establishments

University of Aberdeen
University of Aston in Birmingham, Department of Civil Engineering,
Buckinghamshire College of higher Education
Cranfield School of Management
Cranfield Institute of Technology - Centre for Transport Studies
University of East Anglia, School of Environmental Sciences
Leeds University, Department of Mining and Mineral Sciences
University of Newcastle Upon Tyne, -Department of Soil Science,
-Transport Operations Research Group
The Open University
Portsmouth Polytechnic - Department of Civil Engineering,
Southampton University, Department of Biology
University College Swansea, Zoology Department.
University of Manchester
Manchester Business School
University of Lund, Sweden
Bowdoin College, Maine, U.S.A.

A SOCIAL APPRAISAL OF THE ENVIRONMENTAL IMPACTS OF RETURNABLE AND NON-RETURNABLE CONTAINERS FOR CARBONATED BEVERAGES

Appendices I - XV

by

J.C.D. FISHER

A Thesis submitted for

the degree of

Doctor of Philosophy

1982

University of Leicester

Public Sector Economics Research Centre

APPENDIX I

VARIOUS COUNTRIES' POLICY MEASURES CONCERNING CARBONATED BEVERAGE CONTAINERS[1]

Australia

South Australia promulgated a Beverage Container Act which:-

- prohibited the sale of beer and soft drinks in non-returnable bottles and in cans with detachable ring pull opening devices;
- required that beverage cans with non-detachable opening devices must bear a refundable deposit;
- required that each beverage container must be marked showing the level of the refundable deposit on that container.

The Australian Environment Council's litter control committee has launched a study on the economic implications of the implementation of mandatory legislation throughout all Australia.

Canada

(i) Alberta

In 1971 the Beverage Containers Act was passed which stipulated:-

- a mandatory deposit-refund system for all carbonated soft drinks containers;
- the establishment of depots for the acceptance of soft drink containers.

---

(1) The information on the policy measures presented in this Appendix was derived from: Peaker (1975); U.S. Environmental Protection Agency (1977); OECD (1978); Lidgren (1980); Moullin (1980); Waste Management Advisory Council (1980); Garmin (1982), Hamalainen (1982), Holdt (1982), Lieben (1982); and Personnel Communication with the Waste Management Branch of the Environment Protection Service, Environment Canada, Ottawa.

(ii) British Columbia

In 1970 regulations were passed which stipulated:-

- mandatory deposit-refunds for all carbonated soft drinks and beer containers;
- a ban on beverage cans with detachable opening devices (ring pulls);
- the provision of depots for the return of containers.

(iii) Manitoba

There is a voluntary agreement between the provincial government and the beverage industry for the withdrawal of cans with detachable ring pull opening devices.

(iv) New Brunswick

In 1978 regulations were passed under the Beverage Containers Act which stipulated:-

- a ban on cans with detachable opening devices;
- mandatory deposit-refunds for refillable soft drinks containers;
- mandatory availability of refillable soft drinks containers at the retail outlets.

(v) Nova Scotia

- Soft drinks in refillable bottles must be given equal shelf space to those in one-trip bottles, matching by brand, size and flavour.
- There is a minimum deposit on refillable bottles, ranging from 10¢ for 10fl.oz. bottles to 40¢ for 1.5 litre bottles. The refund is mandatory.
- Beverage cans must have non-detachable opening devices from 1.4.79.

(vi) Ontario

In 1971 regulations were passed under the Environmental Protection Act which stipulated:-

- mandatory deposit refunds for refillable soft drinks containers;

- mandatory availability and equal shelf space for refillable soft drinks containers;

- a ban on beverage cans with detachable ring pull devices;

- a ban on the use of new plastic containers, aluminium beverage cans and some sizes of non-refillable glass bottles for carbonated soft drinks.

In addition, there is an agreement between the beverage industry and government to reduce the use of cans and non-returnable bottles for carbonated soft drinks to 25 per cent of total sales.

(vii) Prince Edward Island

Under the Environmental Protection Act the following measures were passed in 1977 which stipulated:-

- mandatory deposit refunds for refillable carbonated soft drinks containers;

- a ban on non-refillable bottles for beer and carbonated soft drinks;

- the approval of the Minister is required before a new container can be introduced.

(viii) Quebec

In 1978, a tax was introduced on non-returnable beverage containers. The level of the tax was initially 2¢ for containers of 16oz. and under and 5¢ for containers larger than 5¢. The tax level was scheduled to rise by 1¢ per year until it reached 5¢ and 10¢ respectively. (about 2 pence and 4 pence - U.K. currency - respectively).

(ix) Saskatchewan

In 1973 regulations were passed which stipulated:-

- mandatory deposit-refund system for refillable soft drinks and beer bottles;

- bans on cans and non-returnable bottles for soft drinks and beer, except in various special uses (such exceptions have been granted and, in practice, 20 per cent of beer and soft drink sales are still in non-refillable containers);

- government approval is required for all new beverage containers.

Denmark

The use of non-returnable containers for carbonated soft drinks has been banned since 1977.

For beer, the use of beer cans was originally being phased out through a voluntary agreement between the authorities and the breweries and the retail trade.

Then, in 1982, the government implemented a regulation to ban the use of non-returnable containers for beer and carbonated soft drinks, to limit the number of different types of refillable bottles for beer and soft drinks and ensure the maintenance of an efficient returnable system for the distribution of carbonated beverages.

In 1982 a A duty was levied on retail packaging for various beverages. Beer and soft drinks are included within the scope of this duty which, in 1978, was set at 20-90 ore per container depending upon the container's volume. In 1982, the level of this duty was increased to 30-135 ore per container, which in terms of U.K. currency is equivalent to about 2-10 pence.

Finland

A special tax of 0.36-0.6 F.Mks per litre was imposed in 1976 on all non-returnable containers for beer and soft drinks. The level of ths tax was raised in 1980 to 1 F.Mk per litre. The government has recently increased the tax on non-returnable glass and metal containers for soft drinks from 1 F.Mk to 3 F.Mks per litre. At the increased level, this special tax would be equivalent to about 35 pence (U.K. cuirrency).

France

There is a voluntary agreement between the government and industry which will run from January 1980 to December 1984. The major objectives specified in this agreement are:

- development of innovations in the design of beverage containers. This includes the achievement of: a 12 per cent reduction in the energy consumed per hectolitre bottled; an 8 and 6 per cent reduction in the weight of glass and plastic containers, respectively, by 1984;

- a 40 per cent reduction in the weight of beverage containers in household waste;
- recycling of waste glass from households to increase to 450,000 tonnes p.a. by 1983;
- an increase in the use and return rate of returnable glass bottles for beverages.

An annual review will be undertaken to monitor progress towards the achievement of these objectives.

Greece

The government has financed a study of beverage containers. The objectives of this study are to reduce the energy required for the manufacture of glass bottles, increase the use of returnable bottles and reduce the amount of cans used for soft drinks.

Norway

In Norway, there has been a mandatory deposit-refund system for beer and soft drinks containers for many years.

In 1974, the government introduced a tax of 0.80 Norwegian Kronor on each non-returnable container for beer and carbonated soft drinks. At the time of its introduction, this tax raised the price of beer cans by 30 per cent. This tax has since been raised, in 1982, to 1.25 N.Kr. per container which, in terms of U.K. currency, is equivalent to about 12 pence.

There is compulsory standardisation of beer and soft drinks bottles as regards size and voluntary standardisation as to shape, colour and weight.

There is a voluntary agreement between the beverage industry and the government for the prevention of the re-introduction of non-returnable bottles in the Norwegian beer and carbonated soft drinks market.

A study on beverage containers has been undertaken. The objective of this study was to assist the discussions concerning how the beverage container systems in Norway could be improved.

Portugal

A mandatory deposit-refund system for beer containers has been operated since 1979.

Discussions are being held on extending mandatory deposits to soft drinks and mineral waters.

Sweden

In 1973, the Swedish government levied a tax of 12 ore on all (returnable and non-returnable) carbonated beverage containers. In terms of U.K. cuirrency, this is equivalent to about 1 pence.
Investigations concerning beverage container systems are currently being undertaken.

United Kingdom

In a report produced in 1980, the Waste Management Advisory Council has recommended that:

- where this is viable, the recycling of beverage containers should be increased through the collaboration of industry, local authorities, consumers and voluntary organisations.

- The beverage industry should endeavour to improve the existing returnable system by undertaking a continuous campaign to raise trippage and by agreeing on a greater degree of standardisation.

- The bottlers should collaborate with retailers to ensure that the consumer is informed that the price of a carbonated beverage in a returnable bottle includes a (refundable) deposit.

- All returnable bottles should bear a clear indication of returnability.

The implementation of these recommendations is now being examined by the U.K. government.

United States

(i) California

In 1972, the Solid Waste Management and Resource Recovery Act was passed which required the Solid Waste Management Board to investigate changes in current product characteristics and production and packaging practices which would reduce, at source, the amount of solid waste generated.

In January 1979, detachable ring pulls on cans were banned.

(ii) Colorado

An annual litter tax is levied on the gross proceeds of sales by retailers. The revenue is used to fund a comprehensive anti-litter programme.

(iii) Connecticut

From January 1980, all beverage containers must bear a 5¢ deposit and cans with detachable opening devices (ring pulls) have been banned.

(iv) Delaware

There is a mandatory deposit-refund system for all beverage containers and a ban on the use of biodegradable plastic carriers and detachable ring pulls for cans.

(Similar legislation has been passed in Pennsylvania and Maryland).

(v) Hawaii

A Litter Control programme has been undertaken and, from January 1979, detachable ring pulls are banned.

(vi) Iowa

There is a mandatory deposit-refund system for all beverage containers and a ban on detachable ring pulls.

(vii) Kentucky

Under a Litter Control Act a tax has been levied on wholesalers' sales of 16 products that are prominent constituents of litter.

(viii) Maine

In a referendum in 1976, Bottle Bill legislation was accepted which required that there must be a 5¢ deposit on all beverage containers and a ban on both detachable ring pulls and plastic loop carriers for cans.

(ix) Maryland

Legislation as Delaware.

In addition, in one county, retailers are required to mark up the 'net' prices of beverages in refillable bottles less the deposit on the bottle.

(x) Michigan

In a referendum in 1976, Bottle Bill legislation was accepted which required that:-

- all beer and soft drink containers carry a refundable deposit of 10¢ except "certified" ones which should have a 5¢ deposit. ("Certified" meaning a beverage container that is re-usable by more than one bottler)

- Cans with detachable ring pulls are banned.

(xi) Minnesota

There is a ban on detachable ring pulls.

In 1973, a comprehensive law was passed to reduce the amount and types of materials entering the solid waste stream. This law gave the Minnesota Pollution Control Agency the authority to review new or revised beverage containers and to prohibit a new container if it constitutes a solid waste problem or is inconsistent with State environmental policies.

(xii) Massachusetts

Industry has funded a litter/recycling programme.

(xiii) Oregon

In 1972 legislation was implemented which required that:-

- there must be a refundable deposit of at least 2¢ on standard refillable containers for carbonated beverages that can be used by more than one manufacturer;

- there must be a refundable deposit of at least 5¢ on non-standard refillable and one-trip containers (including cans) for carbonated beverages;

- cans with detachable ring pulls are banned.

- retailers, wholesalers and distributors must accept and redeem the deposits on returned empty containers if they distribute or sell that kind, brand and size of beverage.

- containers must be clearly marked as to refund value.

(xiv) Pennsylvania

Legislation as Delaware.

(xv) South Carolina

There is a ban on detachable ring pulls.

(xvi) Virginia

Under a 1977 Act, a tax of $2.50 has been imposed on every person engaged in business allied to products likely to be littered.

Detachable ring pulls banned.

(xvii) Vermont

In 1973, legislation was implemented which required that:-

- there must be a 5¢ minimum refundable deposit on all beer and soft drinks containers;
- a handling charge of 20 per cent of the deposit should be paid by the manufacturer or distributor to the retailer;
- clear labelling on each container of the level of the deposit and the name of the State where the deposit is valid.

The following Amendments to this law came into effect in 1977:

- a ban on non-certified glass containers which cannot be refilled more than five times;
- a ban on detachable ring pulls and non-biodegradable plastic loop carriers for cans.

(xviii) Washington

A litter control and clean-up programme has been undertaken since 1971. This programme is financed by a tax of 0.015 per cent of the gross sales of companies whose products are major components of litter.

West Germany

Beverage container policy is embodied in the government's overall waste management policy. The objective of the beverage container policy is to prevent any increase in the amount of beverage containers in domestic solid waste.

There is a voluntary agreement between the government and the beverage industry which specifies that:

- the glass industry will reduce considerably the weight of glass containers;

- the glass industry will increase the recycling of post-consumer waste glass by 20 per cent p.a. up to an annual level 450,000 tonnes in 1981;

- the steel industry must increase its use of post-consumer tinplate scrap from 100,000 to 250,000 tonnes between 1977 and 1981,

- a non-returnable plastic bottle will not be introduced to the German soft drinks market.

- The beverage industry (bottlers/brewers and retailers) will endeavour to apply more uniformly the deposit system for returnable containers.

The government reviews the progress made toward the achievement of these objectives and targets and reserves the right to introduce legislative controls.

International Organisations

Organisation for Economic Co-operation and Development (OECD)

The OECD undertook an in-depth study of beverage containers and, in 1978, produced a report "Beverage containers: Re-use or Recycling". As a result, the OECD Council adopted the following Recommendation in 1978:

- Member countries should, where practicable, define and implement policy measures designed to ensure that the adverse environmental costs of beverage containers are effectively and equitably borne by the producers and users of such containers;

- Member countries should adopt measures to maintain or, where necessary, to introduce a refillable system for the distribution of beverages when it is expected that, in so doing, the social costs of the beverage distribution system are minimised.

- when measures are undertaken to promote the use of refillable beverage containers, they should be accompanied by (international) efforts to standardise refillable beverage containers.

- Regardless of the measures taken to promote the re-use of beverage containers, Member countries should encourage the recycling of beverage containers and should take any other steps necessary to reduce as much as possible their adverse effects on the environment.

The European Economic Community (EEC)

The EEC has been undertaking (since 1976) an extensive study of beverage containers.

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APPENDIX II

DETAILS OF THE INFORMATION AND ASSUMPTIONS USED TO COMPILE THE SCENARIOS FOR 1982

Background information and assumptions used in deriving the data presented in Table II.1.

(1) The data on the total market for packaged beer and carbonated soft drinks for 1977 and 1982 was obtained from Metal Box's Market Research Division. The data on cider was derived from information provided by Metal Box and from data in the Waste Management Advisory Council's Report [WMAC (1980)].

(2) The data on 'OFF' premise sales of beer and carbonated soft drinks for 1977 was derived after extensive discussions with Metal Box's Market Research Division. An estimate was first obtained from the brewing industry for the sub-division of total beer sales between 'on' and 'off' premise sales. Assumptions were then made for the split between 'on' and 'off' sales of beer in cans, non-returnable bottles and 6 oz., pint and 40 oz., returnable bottles. The residual 'off' premise sales were then allocated to the remaining half-pint returnable bottles. A similar procedure was used for the derivation of the estimates of 'off' premise sales of carbonated soft drinks. These assumptions had been developed on the basis of interviews with the beverage industry. The resulting figures for 'off' premise sales, shown in Table II.1, are the best available

informed guesstimates that could be made on this difficult but important aspect and, inevitably, cannot represent perfectly precise figures. The 'off' premise sales of cider for 1977 were derived on the basis of a combination of a similar set of assumptions and some estimates for 'off' premise market shares given in Cawdell (1980).

(3) 'OFF' premise sales in each size of beverage container have been assumed to form in 1982 the same percentage of the total sales in each container size as they did in 1977.

(4) In scenario II, the 'off' premise sales of beer in cans are shown in Table II.1 to account for 82 per cent of the total volume of 'off' premise beer sales. This is close to WMAC's forecast [WMAC (1980, p.82)] that 'by 1982, metal cans will probably account for 85 per cent of the total take home market'.

(5) Aluminium cans have been assigned 15 per cent of the canned beverage market in 1977. This share is expected to increase to 25 per cent in 1982.

(6) On account of lack of data on forecasts for the weight, in 1982, of the various individual beverage containers, the weights of these containers in 1977 has been used in the analysis of the scenarios. Thus the analysis does not allow for any reduction in the external costs of beverage containers as a result of the development of lighter returnable and non-returnable beverage containers that might occur,

particularly in the extreme cases such as the completely non-returnable system in scenario III or the completely returnable system in scenarios VIII and IX. This leads to an overestimation of the level of the external costs generated by beverage containers in 1982.

(7) The 1982 scenarios II-IX do not include the non-returnable plastic PET bottle which entered the market in 1980 and whose sales are predicted to be about 45 million litres in 1982 [WMAC (1980)].

(8) For scenario III, the volume of beverage sales in the various sizes of returnable bottles - under scenario II for 1982 - have been assigned to their closest equivalent sized non-returnable containers. The proportions, in which these sales of returnables were allocated, were determined by the forecasts for the relative 'off' premise sales volumes of the appropriately sized containers in 1982 under the baseline scenario II. Thus the 42 million litres of beer sales in 10 oz. returnable bottles have been allocated to the 10 oz. non-returnable bottle (+ 9m. litres), the 10 oz. bimetallic cans (+ 25m. litres) and the 10 oz. aluminium cans (+ 8m. litres).

(9) Scenario VII is based upon the predictions given in Friends of the Earth's minority report to WMAC [Cawdell (1980)]. The non-returnable bottle's share of the carbonated beverages market is assumed to fall to zero. The can's share of the beer market falls to

40 per cent. The volume of beer sales in 1982 in the various sizes of non-returnable bottles under scenario II and the change in beer sales in cans between the baseline scenario II and this scenario VII have been allocated to the (closest) equivalent size of returnable. The volume of 'off' premise sales of carbonated soft drinks in cans was assumed to remain the same (as under the baseline scenario II for 1982) since cans lose some sales to returnables but gain a similar amount from non-returnables [Cawdell (1980)]. The volume of carbonated soft drinks' sales in the various sizes of non-returnable bottles under scenario II have been allocated to the closest equivalent size of returnable. The sales volume of cider in the 26 oz. and litre non-returnable bottles under scenario II have been allocated to the closest equivalent returnable bottles and metal cans in proportion to the relative market shares held by these cans and returnable bottles under scenario II.

(10) In scenarios IV, V and VI, VII AND IX, the changes in the volume of beverage sales in the various sizes of non-returnables under these scenarios (in comparison with the baseline scenario II) have been allocated to the closest equivalent size of returnable.

(11) The analysis is improved by the use of this rather more complicated method of apportioning the changes in the market shares of returnables and non-returnables between the different sizes of containers because this

method picks up more effectively and specifically the effect on external costs of a shift in the beverage market from non-returnables to returnables, and vice versa, as distinct from changes in the average size of the containers for beverages.

TABLE II.1 TOTAL AND OFF PREMISE SALES OF CARBONATED BEVERAGES IN THE VARIOUS CONTAINERS UNDER THE DIFFERENT SCENARIOS I-IX for 1977 AND 1982

Beverage Type	Container (i)	Size	TOTAL PACKAGED BEVERAGE SALES 1977 Vol. (10^6L)	1977 Units (10^6)	1982 Vol. (10^6L)	1982 Units (10^6)	'OFF' PREMISE BEVERAGE SALES UNDER SCENARIOS I - IX: I = 1977 Vol. (10^6L)	I = 1977 Units (10^6)	II = 1982 Vol. (10^6L)	II = 1982 Units (10^6)	III Vol. (10^6L)	III Units (10^6)	IV Vol. (10^6L)	IV Units (10^6)	V & VI Vol. (10^6L)	V & VI Units (10^6)	VII Vol. (10^6L)	VII Units (10^6)	VIII & IX Vol. (10^6L)	VIII & IX Units (10^6)
Beer	RB	6oz	24	144	16	96	5	29	3	19	-	-	4	24	4	24	6	35	6	35
		10oz	702	2473	474	1668	62	218	42	146	-	-	62	220	88	308	115	403	160	563
		20oz	132	232	89	157	106	186	72	125	-	-	172	302	344	601	440	774	773	1361
		40oz	15	13	10	9	15	13	10	9	-	-	25	22	44	39	60	52	96	84
	NRB	6oz	3	16	3	18	3	16	3	18	6	37	2	12	2	11	-	-	-	-
		1/4L/10oz	16	62	28	111	14	56	25	100	34	135	17	66	15	60	-	-	-	-
		16-26oz	5	9	20	36	5	9	20	36	22	39	14	24	12	22	-	-	-	-
		Litre	7	7	12	12	7	7	12	12	22	22	8	8	7	7	-	-	-	-
	CAN-BM	10oz	145	511	90	318	112	395	70	246	95	334	61	213	43	152	34	120	-	-
	-AL	10oz	26	90	30	106	20	70	23	82	31	110	20	70	14	50	11	39	-	-
	-BM	16oz	285	626	510	1123	284	626	511	1123	564	1240	441	969	313	689	250	549	-	-
	-AL	16oz	50	110	170	374	50	110	170	374	187	412	146	323	104	230	83	183	-	-
		PARTY	54	19	74	26	54	19	74	26	74	26	63	22	45	16	36	13	-	-
Cider	RB	10oz	33	116	34	120	3	12	3	12	-	-	6	20	6	21	4	14	11	38
		40oz	84	74	87	77	35	31	36	32	-	-	45	39	60	52	97	85	100	87
	NRB	26oz	10	14	16	22	9	12	14	19	22	30	12	16	9	12	-	-	-	-
		Litre	35	35	55	55	32	32	50	50	78	78	43	43	31	31	-	-	-	-
	CAN BM	12-16oz	4	12	8	20	3	9	6	16	8	22	4	11	4	10	7	22	-	-
	AL	12-16oz	1	2	2	7	1	2	2	5	3	8	1	4	1	3	3	7	-	-
Carbonated Soft Drinks	RB	7oz	214	1606	205	1533	-	-	-	-	-	-	1	6	1	14	4	32	4	32
		10oz	9	30	11	39	6	20	7	25	-	-	64	226	245	861	104	366	623	2193
		26oz	342	461	217	294	242	327	154	207	-	-	167	225	184	248	231	311	231	311
		40oz	526	448	630	554	326	287	403	355	-	-	438	385	484	426	612	539	612	539
	NRB	7oz	11	85	5	36	10	76	4	32	4	32	3	24	3	18	-	-	-	-
		8-10oz	86	345	100	400	84	335	97	388	98	392	81	324	59	238	-	-	-	-
		12oz	6	18	-	-	5	14	-	-	-	-	-	-	-	-	-	-	-	-
		13-20oz	49	124	64	162	49	124	64	162	192	482	53	134	39	99	-	-	-	-
		26oz	13	17	13	18	13	17	13	18	39	53	11	15	8	11	-	-	-	-
		Litre	130	130	232	232	117	117	209	209	612	612	174	174	128	128	-	-	-	-
	BM	12oz	388	1139	433	1271	349	1025	389	1144	393	1152	358	1052	239	700	389	1144	-	-
	AL	12oz	69	201	145	424	62	181	130	382	132	386	120	351	80	233	130	382	-	-
TOTAL Beer, Cider & Carbonated Soft drinks	RB		2081	5597	1773	4547	800	1123	730	930	-	-	984	1469	1460	2594	1673	2611	2616	5243
	NRB		371	862	548	1102	348	815	511	1044	1129	1912	418	840	313	637	-	-	-	-
	CAN-BM		876	2307	1115	2758	802	2074	1050	2555	1134	2774	927	2267	644	1567	716	1848	-	-
	CAN-AL		146	403	347	911	133	363	325	843	353	916	287	748	119	516	227	611	-	-
GRAND TOTAL			3474	9169	3783	9318	2083	4375	2616	5372	2616	5602	2616	5324	2616	5314	2616	5070	2616	5243

(i) RB = Returnable glass bottle; NRB = Non-returnable glass bottle; BM = Bimetallic can; AL = Aluminium can

Source - Metal Box Market Research Division
- Waste Management Advisory Council (WMAC), (1980), Study of Returnable and Non-returnable Containers. Report of the Packaging and Containers Working Party of the Waste Management Advisory Council, London.
- Cawdell, A., (1980), Study on Returnable and Non-returnable Containers. Minority Statement of A. Cawdell (Friends of the Earth) to the Packaging and Containers Working Party of the Waste Management Advisory Council, London.

APPENDIX III Instructions sheet circulated to County Councils for the DOE's 1978 Waste Composition Analysis.

The Separation of Beer and Soft Drinks Bottles and Cans in the Composition Analyses of Solid Waste

Purpose of the Analysis

The purpose of this analysis of solid waste is to identify the level of solid waste generated by returnable and non-returnable bottles and 'tin' cans for beer, cider and carbonated 'fizzy' soft drinks. This will enable estimation of the size of the beverage container component in solid waste. This generation of solid waste is an important issue in the current debate over returnable and non-returnable beverage containers and this information would be a very useful input into the government's Waste Management Advisory Council's study of this question. It is noted that there are considerable regional variations in the composition of solid waste. This means that it will be necessary to ensure that the survey will cover as much of the country as possible. Therefore it is hoped that as many local authorities as possible will participate in the survey. This would yield some very useful information on this important question.

The analysis will be undertaken by separating into 6 beverage container categories the glass and metal content arising from the refuse composition analysis performed by local authorities as part of the Department of the Environment's annual composition survey. These 6 categories are given below along with a set of instructions drawn up to aid the identification and separation of the bottles and cans into these 6 categories.

The categories are :-

	Beer and Cider	Carbonated Soft Drinks
Returnable glass bottle	X	X
Non-returnable glass bottle	X	X
Cans	X	X

The glass and metal component should be split up into the 6 categories above and the weight of the contents of each category measured and recorded.

N.B. It is not necessary to analyse containers for other beverages (milk, fruit cordial squashes, wines and spirits). These beverage containers are excluded from the analysis.

Instructions to Aid this Separation Procedure

(a) Cans

All beverage cans are coated with an enamel label. This makes their identification and separation into soft drinks, beer and cider cans very straight forward. It is not necessary to distinguish between the all aluminium cans and cans with a tinplate body and aluminium top.

(b) Returnable and Non-Returnable Glass Bottles

There are a number of ways of identifying returnable and non-returnable bottles and distinguishing between beer cider and carbonated 'fizzy' soft drinks, and other beverages (e.g. milk, cordials, wines and spirits). The most important o these identifying features are :-

(i) The easiest identification method is the label. In most cases this should enable identification of the bottle's product (i.e. beer, carbonated soft drinks or cordial fruit squashes). Frequently the label will also contain a prominent statement that the bottle is non-returnable or returnable (e.g. the hand it back symbol used by BARRS).

(ii) Many bottles have distinguishing features embossed on the actual bottle, e.g. some bottles have the words returnable or non-returnable (e.g. no deposit, no return) embossed on them;

(iii) An important identifying feature is the presence of 'stippling' - a row of small rough dots - on either the shoulders, where the bottle narrows, or bottom of the bottle, or both. All bottles with stippling in either of these places are non-returnable bottles. (N.B. Corona bottles have some dots elsewhere (by the neck of the bottle) and not at these two places above. These bottles are returnable).

Further Characteristics of the Bottles that will aid this identification procedure:-

(iv) Some non-returnable beer and soft drinks bottles with a distinctive wide mouth have just come onto the market. These short squa bottles do not have stippling in the places mentioned in (iii) above, but are still non-returnable.

(v) Bottles (both large and small) which have words (such as 'Coca Cola') embossed in white paint on them are returnable.

(vi) Finally the shape of the bottle will frequently indicate the bottle's contents and enable the elimination of wines and spirits bottles from the analysis.

The six identifying features (i) - (vi) above should enable the glass fraction to be separated into its respective categories. The consultant, or his assistant, is willing to meet with any interested local authorities to give them further details on the aims and procedures for the composition analyses. If you have any comments or queries on the above instructions then please do not hesitate to contact :-

Jonathan Fisher,
Public Sector Economics Research Centre,
University of Leicester,
Leicester LE1 7RH

(Tel. Leicester (0533) 59786).

If the glass sample contains some bottles which it is not possible to classify as returnable or non-returnable in the light of the features (i) - (vi) above, then these bottles should be put into a separate category of unclassifiables and shown to the consultant or his assistant who will endeavour to visit those loca authorities participating in this sampling exercise.

It will probably not be possible to separate the broken glass fraction into the respective returnable/non-returnable categories. Therefore, it is desirable to ensure that as far as possible the bottles are not broken during the refuse collection, sampling and separation process.

List of the Local Authorities that Participated in the Analysis of the Beverage Container Component of Solid Waste in 1979 (and also 1979 and 1980)

1. Berkshire
2. Cambridgeshire
3. Cleveland
4. Cornwall
5. Dundee
6. Dorset
7. Durham
8. Essex
9. Glasgow
10. Hampshire
11. Leicestershire
12. Merseyside (Also in 1980)
13. Northamptonshire
14. Oxfordshire
15. Suffolk
16. Tyne and Wear
17. West Sussex
18. West Yorkshire (Also in 1979)
19. South Yorkshire
20. Falkirk
21. Roxburgh

Appendix IV - Details of the materials balance calculations of the size of the Beverage container component of Domestic Waste

Beverage Containers			'OFF' Premise Sales Quantities 1977 (millions)	SOLID Waste Generated Tonnes	
Type	Size	Unit wgt (grams)		$T_{RB} = 1$	$T_{RB} = 4$
(A) Beer					
Returnable Bottle (RB)	6 oz	241	29	6,989	1,747
	10 oz	300	218	65,400	16,350
	20 oz	470	186	87,420	21,855
	40 oz	675	13	8,775	2,194
Non-Returnable Bottle (NRB)	6 oz	150	16	2,400	2,400
	10 oz	200	56	11,200	11,200
	20 oz	365	9	3,285	3,285
	litre	600	7	4,200	4,200
CANS	10 oz(AL)	18	70	1,260	1,260
	10 oz(BM)	42	395	16,590	16,590
	16 oz(AL)	23	110	2,530	2,530
	16 oz(BM)	55	626	34,430	34,430
	Party	310	19	5,890	5,890
(B) Soft Drinks					
RB	< 7 oz	300	-	-	-
	10 oz	355	20	7,100	1,775
	26 oz	580	327	189,660	47,415
	litre	778	287	223,286	55,822
NRB	< 7 oz	170	76	12,920	12,920
	10 oz	210	335	70,350	70,350
	12 oz	255	14	3,570	3,570
	13-20 oz	350	124	43,400	43,400
	26 oz	500	17	8,500	8,500
	litre	630	117	73,710	73,710
CANS	12 oz(AL)	18	181	3,258	3,258
	12 oz(BM)	42	1,025	43,050	43,050
(C) Cider					
RB	10 oz	300	12	3.600	900
	40 oz	675	31	20,925	5,231
NRB	26 oz	500	12	6,000	6,000
NRB	litre	600	32	19,200	19,200
CANS	12 oz(AL)	18	2	36	36
	12 oz(BM)	42	9	378	378
Total Annual Carbonated Beverage Container Waste =				979,312	519,446
Total U.K. Domestic Waste ≏ 14 m tonnes					
Carbonated Beverage Containers as % of Total Domestic Waste =				7.0%	3.7%

Notes: (1) AL = Aluminium Can.
BM = Bimetallic Can (tinplate body with aluminium top).

(2) The above figures for the sales in bimetallic and alluminium cans are based upon the assumption that the aluminium can held 15% of the market for canned beverages in 1977.

(3) A Trippage of 4 has been assigned to the returnable bottles.

SOURCE:
- Metal Box Market Research Division.
- Society of Country Treasurers (1977), Waste Disposal Statistics, based on estimates 1977-8.
- Chartered Institute of Public Finance and Accountancy (CIFA) (1977), Refuse Collection Statistics, 1976-77, CIPFA, London.

APPENDIX V

AIR AND WATER POLLUTION EMISSIONS FROM THE PROCESS STAGES FOR THE FOUR MAIN CONTAINER SYSTEMS FOR BEER

Introduction

This appendix presents a summary of the data and information contained in the U.S. Environmental Protection Agency's report [US EPA (1974)]. The tables and accompanying text in sections V.1 and V.2 give an indication of the pollutants generated by the various process stages involved in the beverage container systems. The tables in section V.3 highlight the process stages that contribute a major proportion of the total pollution emissions from the beverage container systems. However, it should be noted that this data from the EPA study relates to the U.S.A. and that this EPA study was completed in 1974. Therefore, this EPA study's data presented in this appendix can give an indication of, but will not necessarily be equivalent to, the pollution emissions currently generated by the U.K. beverage container systems.

V.1 Air pollution emissions

V.1.1 Aluminium can system

Table V.I shows that the major air pollutants from the Aluminium can system are sulfur oxides (SO_x), Nitrogen oxides (NO_x), particulates, hydrocarbons and carbon monoxide (CO). The principal source of these

Table V.1

The Emissions of Specific Air Pollutants from the

Alternative Container Systems

(Kgs. per 1000 Litres of Beer Distributed)

Air Pollutant(1)	CONTAINER SYSTEM				
	Returnable 19-trip	Bottle 5-trip	Non-returnable Bottle	Bimetallic Can	Aluminium Can
Particulates	1.80	6.67	8.97	6.16	6.36
NO_x	1.61	3.73	5.59	4.08	7.06
Hydrocarbons	1.16	2.66	4.85	5.4	5.85
SO_x	2.47	7.22	7.6	8.04	15.93
CO	0.99	2.10	2.815	2.32	3.32
Aldehydes	0.02	0.03	0.04	0.02	0.03
Other Organics	0.04	0.105	0.115	0.04	0.04
Odorous sulfur	0.31	1.364	1.03	0.16	0.03
Ammonia	0.04	0.093	0.28	0.33	0.003
HF	-	-	-	0.03	0.06
Lead	0.001	0.001	0.003	0.001	0.0006
Mercury	-	-	-	0.0001	0.0003
Chlorine	0.017	0.017	-	0.017	0.05
Total Air Pollution Emissions	8.46	24.0	31.29	26.6	38.7

Source: US EPA (1974)

(1) where NO_x = Nitrogen oxides
SO_x = Sulfur oxides
CO = Carbon monoxide
HF = Hydrogen fluoride

pollutant emissions, particularly sulfur oxides and nitrogen oxides, is the large quantities of electrical energy required for the aluminium reduction, or smelting process. The aluminium reduction process itself generates carbon monoxide, hydrocarbons, sulfur oxides and gaseous and particulate fluorides emissions. In terms of the weight of emissions, the carbon monoxide emissions are larger than the fluoride emissions. However, there is more concern amongst the industry and affected parties over the fluoride emissions [Medical Research Council (1949), Department of the Environment (1968), U.S. EPA (1974)]. The other main sources of the aluminium can system's air pollution are the refining of the bauxite into alumina, which results in particulate emissions, and the manufacture of the cans which results in the emission of hydrocarbons.

V.1.2 Bimetallic can system

The major pollutants from the bimetallic can system are sulfur oxides, particulates, hydrocarbons, nitrogen oxides and carbon monoxide. The principal sources of these pollution emissions are the various processes involved in the production of the aluminium closure for this can. These processes were examined in the previous section. The manufacture of the steel, along with the extraction and combustion of the raw materials and energy (mostly coal) required for steel making, are the other main sources of the bimetallic can system's pollution load. The coking, sintering and steel-making processes result in the emission of particulates, sulfur oxides and hydrogen sulphides. The mining of the iron ore generates particulate emissions and the manufacture of the cans results in the emission of hydrocarbons.

V.1.3 Returnable and non-returnable bottle systems

The principal air pollutants from the glass bottle systems are particulates, sulfur oxides, nitrogen oxides, hydrocarbons, carbon monoxide and odorous sulfur emissions. These pollutants come mainly from two process stages: the manufacture of the bottle; and the manufacture of the supplementary packaging. The pollution associated with the manufacture of the glass bottles results primarily from the generation of the large amounts of energy required to produce bottles. The glass manufacturing process itself causes relatively little pollution. Accordingly to the EPA report, the processing of the pulp for the supplementary paper packaging creates considerable pollution problems in the form of emissions of sulfur oxides and particulates and the noticeable odorous sulfur compounds. The remaining processes produce a fairly low contribution to the total pollution load, although the mining of limestone and Feldspar apparently create a local dust problem and the manufacture of lime and soda ash also result in particulate emissions.

V.2 Water pollution emissions

V.2.1 Aluminium can system

Table V.2 shows that the major water pollutants from the aluminium can system are COD, dissolved solids, waterborne chemicals and acids. The principal sources of these water pollutants are the refining of bauxite into alumina and the smelting, or reduction, of the alumina into aluminium. The refining of bauxite, under the bayer process, also results in a residue called 'Red Mud' which presents a major disposal problem for the industry and would constitute a serious pollutant if these residues were discharged untreated into a river. However, in the figures in Table V.2, it has been assumed that these residues are impounded in settling ponds and so are discharged as solid waste. The use of this assumption is substantiated by evidence from other sources [see Budd (1974), OECD (1977)] that such control techniques are commonly adopted by the industry.

V.2.2 Bimetallic can system

The main water pollutants from the bimetallic can system are COD, waterborne acids, dissolved and suspended solids. The principal sources of these pollution emissions are those processes involved in the production of the aluminium top of this can. The manufacture of steel is the other major contributor to the total pollution load of the

Table V.2

The Emissions of Water Pollutants from the
Alternative Container Systems
(Kgs. per 1000 litres of Beer Distributed)

Air Pollutant[1]	CONTAINER SYSTEM				
	Returnable Bottle 19-trip	Returnable Bottle 5-trip	Non-returnable Bottle	Bimetallic Can	Aluminium Can
Fluorides	-	-	-	0.106	0.29
Dissolved solids	0.413	0.95	1.44	0.84	1.37
BOD	2.036	4.6	2.5	0.15	0.27
Phenol	-	-	0.001	0.001	0.003
Sulfides	-	-	0.0008	0.0006	0.0012
Oil	0.006	0.018	0.06	0.224	0.49
COD	0.003	0.006	0.008	0.92	2.44
SS	0.74	2.49	2.39	0.51	0.47
Acid	0.073	0.18	0.29	0.86	0.75
Metal ion	0.019	0.046	0.07	0.22	0.21
Chemicals	-	-	0.0008	0.29	0.785
Cyanide	-	-	-	0.0007	-
Alkinity	-	-	-	-	0.0003
Lead	-	-	-	-	0.00006
Total Water Pollutants	3.29	8.29	6.76	4.12	7.08

Source: US EPA (1974)

(1) Where COD = Chemical oxygen demand
SS = Suspended solids
BOD = Biological oxygen demand

bimetallic can system. The use of wet scrubbers to clean the exhaust gases from steel manufacture results in the emission of dissolved and suspended solids, while the finishing operations (rolling, pickling and plating) generate waterborne waste oils, acids and heavy metal ions. The manufacture of steel requires a considerable amount of energy, principally in the form of coal. Acid mine drainage from coal mining presents a water pollution problem that is difficult to control.

V.2.3 Returnable and non-returnable glass bottles systems

According to the EPA study, the main water pollutants from the glass bottle systems are BOD, suspended and dissolved solids. The principal sources of these water pollution emissions are the processing of the wood pulp and its manufacture into paper packaging. This high contribution of the supplementary paper and board packaging to the total water pollution load of the glass bottle systems is an important reason for the low level of water pollution emissions from the 19-trip returnable system which requires much less supplementary packaging than the 5-trip returnable bottle system.

V.3 The contribution of the specific process stages to the total pollution load

V.3.1 Aluminium can

Table V.3

The Air and Water Pollution Emissions in Kgs. per 1000 litres of Beer delivered, for the process stages in the Aluminium Can System

Process Stage[1]	Air Pollution Emissions	Air Pollution % of total	Water Pollution Emissions	Water Pollution % of total
Extraction and Processing of Raw Materials				
Bauxite Mining	0.8	2.1	0.01	0.1
Bauxite refining	5.84	15.1	3.39	47.9
Aluminium smelting	22.58	58.3	1.78	25.1
Aluminium rolling	1.12	2.9	0.87	12.3
Other Raw Materials[4]	1.56	4.0	0.48	6.8
Manufacture of Can	4.0	10.3	0.19	2.7
Supplementary packaging[2]	0.33	0.8	0.12	1.7
Filling	1.23	3.2	0.13	1.8
Transport[3]	1.23	3.2	0.11	1.6
Disposal	0.04	0.1	0.002	0.03
Total	38.73	100	7.08	100

Source: US EPA (1974)

(1) The EPA study has included, for each of these process stages, the pollution resulting from the actual process and also the pollution associated with the energy required at the process. Some of this energy-related pollution will occur away from the plant site (e.g. the pollution resulting from the generation of energy). This means that the actual plants for the process identified above may in themselves in fact not be significant contributors to the total pollution load.

(2) The pollution associated with the supplementary packaging includes the pollution resulting from the extraction and processing of the raw materials as well as their manufacture into packaging.

(3) This includes the transport between all the process stages involved in the container system (e.g., the transport required at the raw material extraction and processing and container fabrication stages, as well as the distribution of the filled beverage containers).

(4) The EPA study analysed an aluminium can system with a post-consumer recycling level of 15 per cent. The pollution emissions from the recycling operations and from secondary aluminium smelting are included in the category 'Other raw materials'.

V.3.2 Bimetallic can

Table V.4

The Air and Water Pollution Emissions, in Kgs. per 1000 litres of beer delivered, for the process stages in the Bimetallic Can(5) System

	Air Pollution		Water Pollution	
Process Stage(1)	Emissions	% of total	Emissions	% of total
Extraction and Processing of Raw Materials				
Iron ore mining	1.3	4.9	0.02	0.48
Coal mining	0.8	3.0	0.31	7.5
Other raw materials	0.83	3.1	0.04	1.0
Steel strip MFR	5.5	20.7	0.96	23.3
Aluminium closure(4)	12.75	47.9	2.4	58.2
Can manufacture	2.99	11.3	0.08	1.94
Supplementary packaging(2)	0.78	3.0	0.18	4.4
Filling	0.56	2.1	0.04	1.0
Transport(3)	0.98	3.7	0.087	2.1
Disposal	0.1	0.4	0.005	0.11
Total	26.59	100	4.12	100

Source: US EPA (1974)

(1) See Note (1) to Table V.3
(2) See Note (2) to Table V.3
(3) See Note (3) to Table V.3
(4) The pollution associated with the aluminium closure comprises the pollution resulting from the extraction and processing of the raw materials and their manufacture into aluminium closures.
(5) This bimetallic can system is a 3 piece tinplate can with an aluminium top.

V.3.3 Non-returnable glass bottle

Table V.5

The Air and Water Emissions in Kgs. per 1000 litres of Beer delivered for the Process Stages in the Non-returnable Bottle System

Process Stage[1]	Air Pollution Emissions	Air Pollution % of total	Water Pollution Emissions	Water Pollution % of total
Extraction and Processing of Raw Materials				
Glass sand mining	0.5	1.6	0.22	3.2
Soda ash manufacture	3.47	11.1	0.39	5.8
Limestone mining	1.55	4.95	0.003	0.04
Other raw materials	1.35	4.3	0.026	0.4
Manufacture of Bottle	10.2	32.6	0.95	14.1
Supplementary packaging[2]	10.08	32.2	4.83	71.5
Steel closure[4]	0.48	1.5	0.06	0.9
Filling	0.58	1.9	0.05	0.7
Transport[3]	2.51	8.0	0.21	3.1
Disposal	0.57	1.8	0.02	0.3
Total	31.29	100	6.76	100

Source: US EPA (1974)

(1) See Note (1) Table V.3

(2) See Note (2) Table V.3

(3) See Note (3) Table V.3

(4) The pollution associated with the steel closure comprises the pollution resulting from the extraction and processing of the raw materials and their manufacture into steel closures.

V.3.4 Returnable glass bottles

Table V.6

The Air Pollution Emissions in Kgs. per 1000 litres of Beer, for the Processes in the 5-trip, 10-trip and 19-trip Returnable Bottle Systems

Process Stage (1)	Returnable Bottle System 5-trip		10-trip		19-trip	
	Emissions (kgs.)	% of total	Emissions (Kgs.)	% of total	Emissions (Kgs.)	% of total
Extraction and Processing of Raw Materials	2.0	8.3	1.0	8.9	0.53	6.3
MFR of Bottle	2.96	12.3	1.48	13.1	0.78	9.2
Supplementary Packaging (2)	14.88	62.0	4.97	44.1	3.6	42.7
Steel closure (4)	0.46	1.9	0.46	4.0	0.46	5.5
Filling	1.37	5.7	1.37	12.2	1.37	16.2
Transport (3)	1.88	7.8	1.74	15.4	1.59	18.8
Disposal	0.45	1.9	0.26	2.3	0.11	1.3
Total	24.0	100	11.28	100	8.44	100

<u>Source</u>: US EPA (1974)

(1) See Note (1) to Table V.3

(2) See Note (2) to Table V.3. The three returnable bottle systems require different quantities of supplementary packaging (see section 7.3.2 of Chapter 7).

(3) See Note (3) to Table V.3. However, for the returnable systems, the pollution emissions from the transport associated with the extraction and processing of the raw materials and their fabrication into bottles have been included in the figures given above for the pollution from these container-related processes. Therefore the category transport in this table V.6 for the returnable systems just includes the transport required for the process stages involved in the manufacture and distribution of the supplementary paper packaging and closures and the distribution of the beverage containers to and from the retail outlets.

(4) See Note (4) to Table V.5.

Table V.7

The Water Pollution Emissions in Kgs. per 1000 litres of Beer for the Process Stages in the 5-trip, 10-trip and 19-trip Returnable Bottle Systems

Process Stage[1]	Returnable Bottle System 5-trip		10-trip		19-trip	
	Emissions (kgs.)	% of total	Emissions (Kgs.)	% of total	Emissions (Kgs.)	% of total
Extraction and Processing of Raw Materials	0.18	2.2	0.09	2.2	0.05	1.5
MFR of Bottle	0.27	3.3	0.14	3.4	0.07	2.2
Supplementary Packaging[2]	5.89	71.0	1.97	47.5	1.24	37.7
Steel closure[4]	0.06	0.7	0.06	1.5	0.06	1.8
Filling	1.73	20.8	1.73	41.7	1.73	52.7
Transport[3]	0.16	1.9	0.15	3.5	0.13	4.0
Disposal	0.01	0.1	0.007	0.2	0.003	0.08
Total	8.3	100	4.15	100	3.28	100

Source: US EPA (1974)

(1) See Note (1) to Table V.3

(2) See Note (2) to Table V.6

(3) See Note (3) to Table V.6

(4) See Note (4) to Table V.5

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APPENDIX VI

THE PERFORMANCE OF A POLLUTION EMISSIONS STUDY OF THE BEVERAGE CONTAINER SYSTEMS IN THE U.K.: TWO CASE STUDIES

VI.1 Air Pollution - Aluminium smelting

Aluminium smelting, or reduction, was chosen for the air pollution case study because, as is evident in Tables V.3 and V.4 of Appendix V, this process contributes a large proportion of the total pollution emissions from the aluminium and bimetallic can systems. A review of the literature[1] revealed some information on the raw (untreated) pollution load from the smelting process, the pollution control techniques applied by the aluminium industry and the efficiency of these pollution control techniques. This information, along with some data obtained from the U.K. Aluminium industry, enabled estimation of the pollution coefficients for the aluminium smelting process, which are shown in Table VI.1. It was not possible to obtain any information on the ambient concentration levels of these pollutants in the environment around the smelter. Therefore, the damages caused by these emission could not be evaluated.

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(1) This literature included Department of the Environment (1968), BUDD (1974), Miller (1974), OECD (1977).

Table VI.1

Pollution Coefficients for the Aluminium Reduction Process

Pollutant(1)	Residual(2) Pollution Emission Coefficient Kg. per ton of Aluminium
Gaseous Fluorides	2.09 - 4.37
Particulate Flourides	0.295 - 0.57
Total Fluorides	2.385 - 4.94

Source: UK Aluminium Industry
OECD (1977)

(1) The Aluminium Smelting process also results in the emission of other pollutants (e.g., hydrocarbon emissions). However, it was not possible to determine coefficients for these pollutants. Nevertheless, fluoride emissions are the most important pollutant from the smelting process according to the Medical Research Council (1949), the Department of the Environment (1968), and the United States Enviromental Protection Agency [US EPA (1974)].

(2) These residual pollution emission coefficients take account of the efficiency of the control techniques adopted by the Aluminium industry.

VI.2 Water Pollution - Beverage filling

The container filling process was chosen for the water pollution case study since concern has been expressed over the greater quantity of water required to wash returnable bottles and the water pollution resulting from the bottle washing process (Schweppes). Table VI.2 presents data on water pollution emissions from the conditioning, chilling and packaging processes of two breweries, one of which bottled totally in returnable bottles (Brewery 'A") while the other packaged in non-returnable bottles and cans (Brewery 'B'). The figures for the returnable bottling process were obtained from data in Brewery 'A's' annual water effluent charges and from additional information provided by this brewery. The figures for the non-returnable bottling process were derived from data on the water consumption and beer losses for the conditioning, chilling and packaging processes at Brewery 'B', since beer losses are the principal source of water pollution from the non-returnable filling line. The beer losses were multiplied by the BOD value of beer - 90,000 mg per litre [Lones (1973)] - to give an estimate for the BOD load from this filling line. It was not possible to derive an estimate for suspended solids. However, BOD emissions appear to be the more important pollutant [Soltoft (1967)].

Enquiries with the Water Authorities revealed that high BOD and alkaline wastes from the brewing and bottle washing processes of a brewer or bottler in an urban area would be sufficiently diluted by the rest of the sewage entering the municipal treatment plant and therefore no great concern was expressed over these wastes. However, it was stated that certain problems might arise in a rural area, where the brewery's effluent made up a large proportion of the pollution load that the local sewage plant was treating.

Table VI.2

Water Pollution Emissions from the Conditioning Chilling and Packaging Processes at a Brewery bottling in returnables (Brewery 'A') and a Brewery bottling in non-returnables (Brewery 'B') (water effluent per 1000 litres of beer packaged)

Water Effluent	Brewery 'A' Returnable bottle Filling line	Brewery 'B' Non-returnable Filling line
Water Volume (litres)	8720 (ph ≃ 6.5) 80 (ph ≃ 12.8)	6116 (ph ≃ 5.5)
Water Pollutants		
BOD (Kgs.)	24.2	2.7
SS (Kgs)	1.1	?(1)

Source: Data supplied by two breweries

(1) It was not possible to determine the level of Suspended Solid (SS) emissions for the non-returnable bottling situation.

BOD = Biochemical Oxygen Demand
SS = Suspended Solids

despite the expenditure of a considerable amount of effort, these two case studies presented here still contain many shortcomings. Specifically, the data presented in Tables VI.1 and VI.2 were obtained from just a small number of firms. Earlier reports [Institute of Brewing (1972), (Bidwell, 1974)] have shown that there is considerable variation in the quantity and composition of the water pollution emissions from different breweries on account of, among other things, the different production techniques adopted by the individual breweries. Therefore, the two breweries investigated in the above case study may not form a fully representative and comparable sample.

These case studies relate to just two of the processes involved in the alternative beverage container systems. It was emphasised in Section 7.1 of Chapter 7 that any comparison of the pollution impacts of the alternative containers must be made on the basis of the pollution emissions from all the processes involved in the total container system, (i.e. from the extraction of the raw materials through to the distribution of the filled containers to the consumer) and not on just one or two of the processes. This highlights an essential problem that the value of an integral pollution emissions study is greater than the sum of the values of single analyses of the pollution emissions from the individual processes of each container system, since a meaningful ranking of the overall pollution impacts of the container system cannot be derived from a comparison of the pollution emissions from just some of the many individual processes.

This means that, when considering whether a U.K. pollution impact study should be undertaken, it is important to realise, at the outset, the size of the study and the practical problems likely to be encountered in obtaining the data and information required on <u>all</u> the processes involved in each container system. One possible short cut would be to concentrate just on those processes that the US EPA study (US EPA 1974) identified as making a significant contribution to the total pollution emissions from each of the container systems. However, even this abridged study would still require a considerable amount of information and data if it was to be done well, and would still contitute a big and difficult exercise. These practical problems may well explain why a pollution impact study of the beverage container systems has not yet been undertaken for the U.K. and why overseas studies are the only source of any quantitative data that is currently available on this subject.

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Appendix VII

List of areas on which information was sought from the Brewers and Bottlers on the Public Health and Hygiene Impacts of Carbonated Beverage Containers.

(A) General information on Profile of company's plants

(1) Size of plant - sales/production volume - '000's galls p.a.
+ sales split between :-

a) returnable bottles
b) non-returnable bottles
c) metal cans
d) draught.

(2) Whether, at this plant, both the brewing and soft drinks manufacturing and the bottling/filling processes undertaken or is only the filling process undertaken at this plant ?

(3) Name of company (unless for confidentiality reasons this is requested not to be disclosed outside the association).

(4) Location of plant.

(B) Hygiene

(5) The state of the bottles that are returned to you.
e.g.-presence of dirt, contaminants before any cleaning is undertaken;
-proportion of bottles that are returned with bottle(screw) tops on.

(6) Process used for cleaning and sterilizing :

a) returnable bottles;
b) non-returnable bottles;
c) metal cans.

(7) Make of cleaning equipment used.

(8) Type of cleaning compound used.

(9) (a) strength (e.g. in terms of % causticity) of the cleaning solution;
(b) frequency of changing the cleaning solution.

(10) Inspection procedure used to reject substandard returned and new bottles. e.g. Automatic/visual inspection.

(11) The efficiency of the cleaning and visual inspection procedure.

(12) Any evidence and data on cases and/or complaints about the presence of contaminants (e.g. dust, detergents, vermin, mould etc.) occurring in the beverage containers after they have undergone the cleaning operation.

Beverage Container Type	Cases of contaminants per 1,000 units of filled beverages
a) Returnable Bottle	?
b) Non Returnable Bottle	?
c) Metal Can	?

Appendix VIII

Areas where information was sought from the Environmental Health Departments

HYGIENE AND PUBLIC HEALTH

Summary of information areas for the hygiene section of the Waste Management Advisory Council's (WMAC) study of the beverage container question.

Aim of Research = Determine the size, nature and importance of any hygiene problems of beer and soft drinks containers and assess whether an increase in the use of returnable bottles for beer and soft drinks would present any significant hygiene problems for the public and the environmental health officers.

This research will cover two aspects :-

(I) the presence of any contaminants in the beverage;

(II) sanitation problems caused by the storage of beverage containers, and the returned empties, at the retail outlets.

There are a few specific areas where information on local environmental health officers' experiences and practices regarding these two aspects would be a most beneficial input into this section of the WMAC study. These areas are briefly outlined below :-

(I) The presence of any contaminants in the beverage

(i) The number of cases that the EHO has investigated recently (e.g. in the past year or in the last 2 - 3 years) concerning the presence of contaminants in the three alternative containers for beer and soft drinks (returnable glass bottle, non-returnable glass bottle and metal can).

(ii) The type of contaminant in these cases investigated in (i) above.

(iii) The importance that the EHO attaches to these cases of contaminants in the beverage.

(II) Sanitation Problems at the Retail Outlets

(i) The number, and nature, of the cases that the EHO has investigated recently concerning sanitation problems caused by the storage of beer and soft drinks containers and the returned empties, at the retail outlets (i.e. off licences, corner stores and supermarkets etc.).

(ii) The importance that the EHO attaches to these cases of sanitation problems.

(iii) The EHO's opinion on the significance of any hygiene and public health impacts of an increased use of returnable bottles for beer and soft drinks.

I would be most grateful for any information you may have on these areas identified above. If you require any further details on this research project and the areas identified above, then please do not hesitate to contact :

Jonathan Fisher
Public Sector Economics Research Centre,
University of Leicester,
Leicester LE1 7RH.

Tel. Leicester (0533) 59786

Appendix IX

List of points on which information was sought from the Retailers for the Hygiene Impacts of Beverage Containers.

I Hygiene and Public Health

The objective of the research is to determine the extent that beverage containers and particularly returned beer and soft drinks bottles. create anv sanitation and contamination problems while they are being stored at the retail outlets.

There are a number of areas where information on retailers' practices would be very useful to this section of the study. These include :-

(1) current methods used by retailers for storing the empty returnable bottles

e.g. (a) in a separate space, such as an outside shed;
(b) outside the outlet;
(c) in a separate section of the food storage room
(d) whether the returned bottles are subject to any treatment (e.g. fumigation);

(2) whether the retailer has adequate storage space available to enable the returned beverage containers to be kept separate from the rest of his food stocks so as to conform with current environmental health standards (as laid down in sections 6 and 12 of the 1970 Food Hygiene Regulations) and prevent any sanitation and contamination problems occurring;

(3) the state of the bottles that are returned to the retailers i.e.
(a) whether the bottles are dirty or contaminated;
(b) whether, or what proportion of, bottles are returned with bottle tops on;

(4) the usual time period between the deliveries, and the pick up of the empties, by the soft drinks bottlers and brewers. This information is useful since this turnaround time will affect the extent that empty returnables can pose a contamination and odour problem (especially in summer) while they are being stored at the retail outlets;

(5) any evidence and data on sanitation problems occurring at retail outlets as a result of the storage of :

(a) all goods;
(b) all beer and soft drinks containers;
(c) returned empty beer and soft drinks containers;

(6) in order to put this data on cases of sanitation problems into relative perspective, information is also required on the general profile of the retail outlets concerned.

General Profile of Retail Outlet

A) Sales Turnover

- all goods - £'s per annum or per month
- beer and soft drink sales in :-
  - returnable bottles - galls per annum or per month
  - non-returnable bottles and cans - " " " " "

B) Type of outlet

e.g.
(i) Large supermarket
(ii) Small supermarket (e.g. Spars, VG Stores)
(iii) Off licences
(iv) Corner stores
(v) Green grocers
(vi) Confectioners, Newsagents and Tobacconists (CNT)
(vii) Other retail outlets (please specify)

APPENDIX X

List of Points on which information was sought from the distribution managers of breweries and the traffic control authorities on the congestion impacts of the distribution of beverages to the retail outlets

Aim of research on urban congestion = to determine the effect on urban congestion of the distribution of beer and soft drinks to the retail outlets and to assess whether any significant urban congestion problems would arise as a result of an increase in the use of returnable bottles for beverage distribution.

Areas where information is needed to perform this part of the study

1. The opinion of authoritative bodies in the transport sector, such as the distribution managers of brewers and soft drink manufacturers, on the urban congestion caused by beverage distribution lorries, especially when the lorries are parked at the retail outlets loading/unloading the beverage containers.

2. In this respect it will be necessary to obtain the Distribution Manager's opinion on the traffic conditions experienced by his distribution lorries while delivering to the various sales outlets. In particular it will be very useful to obtain information on the traffic situation and conditions at the various retail outlets. W.R.T. :-

(i) size of traffic flows;

(ii) congestion levels;

(iii) existence of traffic and parking controls;

(iv) existence of rear or side access at each of the sales outlets;

(v) ease of parking at these outlets for the firm's vehicles - especially if parking on the street frontage is necessary for delivery to these outlets.

3. It would also be beneficial to obtain the following information on the procedures customarily followed for the delivery of the beverages to the various retail outlets:-

(A) Timing of deliveries, e.g. - peak,
- off peak;

(B) duration of deliveries, i.e. loading/unloading time. One source gives 28 minutes as the average time spent loading/unloading beverage containers at the retailers. The duration of the delivery may be determined by the quantity and type of beverage to be delivered. Therefore information may also be needed on the average batch size of the deliveries and their sub-division between returnables and non-returnables;

(C) the normal time period between the deliveries and pick up of empties from each outlet (this is also useful for the hygiene aspect of the study since it will affect the extent that empty returnable bottles pose a contamination and odour problem (especially in summer) while they are being stored at the retail outlets awaiting collection.

It may well be that the delivery procedures and traffic conditions will be different for the various types of outlets served by the bottler/brewer (e.g. a high street supermarket as opposed to a small suburban 'off' licence or corner store). If this is so, then it will be necessary to ascertain the method that the Distribution Manager uses to classify the various types of outlets, to which he delivers beverages, and to obtain his opinion on the traffic conditions and delivery procedures for each of these outlet types. It will also be useful to determine the subdivision of the firm's beverage sales between the alternative beverage containers (draught, cans, returnable and non-returnable bottles) for the different outlet types given in this classification.

APPENDIX XI

INTRODUCTORY LETTER SENT TO THE HOUSEHOLDERS IN THE CONSUMER SURVEYS

PUBLIC SECTOR ECONOMICS RESEARCH CENTRE

Director: Dr. P. M. JACKSON

UNIVERSITY OF LEICESTER
LEICESTER
LE1 7RH

Tel: LEICESTER (0533) 59786

March, 1979.

STUDY OF RETURNABLE/NON-RETURNABLE BOTTLES

To the Occupier

Dear Sir/Madam,

You may have noticed in the local press that some research is being undertaken at Leicester University into the question of returnable/non-returnable bottles and cans for soft drinks and beer. The research team are currently undertaking a survey of consumers' attitudes on this subject and your household has been selected as one of the houses for the survey. This survey is designed to find out what your views are on the issue of returnable/non-returnable bottles. A member of the research team will be calling at your house on the ....of........................ to ask you some straightforward questions on this matter.

The government is currently reviewing this topical issue and the information from this survey will be a valuable input into both the research at Leicester University and also the government's review of this important subject. We therefore hope that you will participate in this survey.

If the date and time given above proves to be inconvenient to you, and you would like to participate in this study, please complete and post the form below and arrangements will be made for a member of the research team to call at a time suitable to you.

Thank you.

Yours faithfully,

Jonathan Fisher

To:

J. C. D. Fisher,
Public Sector Economics Research Centre,
University of Leicester, Leicester LE1 7RH.

Study of Returnable/Non-Returnable Bottles

It is not convenient for me to be available for interview at the date and time stated but would be at home on .... at .... if the interviewer would like to call.

Yours faithfully,

(Name)..................................

(Address)..................................

....

Introductory Letter – 3 Languages

WASTE SURVEY

Blackburn Waste Survey
Refuge Building
South Wing – 2nd Floor
Ainsworth Street
Blackburn Tel: 58902

Dear Resident,

Your address has been chosen as part of a cross-section of the population of Blackburn. Householders are being invited to participate in a survey carried out by researchers from Manchester, assisted by a team from the Blackburn area.

The aim is to find out how you feel about the large quantities of waste in the U.K. (Blackburn generates some 40,000 tons a year). This is a problem which concerns both local authorities and central government. The survey will provide important information to assist in developing plans for reducing household waste through policies for reclaiming or re-using some materials which at present are thrown away.

Please help us. The questions asked will be straightforward, and the results will be made known by the end of 1979. Participants' names and addresses will not be used. A member of our team will be calling on you within the next few days. He/she will carry an identification card and will be pleased to give you further details about the survey. Please feel free to contact us.

Sincerely,

D.E. Mercer
Research Officer

The project is run by the North West Waste Reclamation Committee, Manchester Business School (University of Manchester), Booth Street West, Manchester in association with the Blackburn Borough Council, and is grant-aided by the Manpower Services Commission.

Source : BLACKBURN WASTE SURVEY: A Study of Public Attitudes to Household Waste Collection and Disposal. Mercer, D., Ng, M., Lowther, C., Chapman, J., Profit from Waste Ltd., Manchester Business School, Manchester 1980.

Refuge Building
South Wing - 2nd Floor
Ainsworth Street
Blackburn Tel: 58902

WASTE SURVEY

શ્રીમાન, શ્રીમતી

તમારા ઘરમાં ઉત્પન્ન થતો કચરો કે જેમાં ખાવાની બોટલો પતરાના ડબ્બાઓ, જૂની પુરાણી વસ્તુઓ - જેવું ફેંકવાપાત્ર વગેરે હોય છે તેવા જેવી વસ્તુઓને તમારી પાસેથી લઈને ફરી ઉપયોગી કરીને નવી વસ્તુઓ ઉત્પાદન કરી શકાય એવી યોજના માટે તમારા સમાચાર-વિચાર શું છે તેની તપાસણી કરવા ગવર્મેન્ટના સાથે બ્રેડફર્ડ યુનિવર્સિટીની ટીમ સર્વે (SURVEY) કરી રહી છે.

ઉપરોક્ત બાબત માટે ઇંગ્લેન્ડના ઘણા પ્રકારના નક્કી કરેલા સ્થળોમાં તમારા મહોલ્લાની પણ પસંદગી થાય છે. આ કામ માટે અમારે તમારી મદદની જરૂર છે તો જ્યારે અમારી ટીમની કોઈ વ્યક્તિ તમારી પાસે ઘરગથ્થુ કચરાને લગતી માહિતીના સવાલો પૂછવા માટે આવે તો આશા છે કે આપ પૂરતો સહકાર આપશો.

તેઓને ઘણા સરળ અને સાદા પ્રશ્નો પૂછવામાં આવશે. તમારા ટીમના દરેક વ્યક્તિ પાસે આઈડેન્ટીફીકેશન કાર્ડ (IDENTIFICATION - CARD) હશે જે તેમના સરકારી તેમની ઓળખાણ માટે તમને બતાવવામાં આવશે.

આ સર્વેના પરિણામનો રિપોર્ટ ઈ.સ. ૧૯૭૯ ની આખર સુધીમાં પ્રસિદ્ધ કરવામાં આવશે જેમાં તમારું નામ કદીપણ જાહેર કરવામાં નહીં આવે. એટલે તમારે કોઈ ફીકર કરવાની જરૂર નથી.

આના કચરામાં રહેલો ઘણો ઉપયોગી કચરો ઉત્પન્ન થાય છે. (પરિપૂર્ણ રીતે ઈ.સ. ૭૦ હજાર ટન કચરો જમા થાય છે) આ કચરાનો ફરી ઉપયોગ કરવા માટે સરકાર કચરામાંથી તેના બાબત માટે તમારા વિચારો જાણવા આ સર્વે કરવામાં આવી રહ્યો છે.

લી. તમારા વિશ્વાસુ
Dorothy C. Mercer રીસર્ચ ઓફિસર
Research Officer

Refuge Building
South Wing - 2nd Floor
Ainsworth Street
Blackburn Tel: 58902

WASTE SURVEY

محترمہ اہل خانہ!

آپ کا گھر اس سروے کے لیے چنا گیا ہے جو کہ بریڈفورڈ یونیورسٹی سے آئے ہوئے ماہرین اور بلیک برن سے ایک ٹیم مل کر شروع کر رہی ہیں - آپ کو اس سروے میں حصہ لینے کے لیے مدعو کیا جاتا ہے ۔

اس سروے کا مقصد یہ معلوم کرنا ہے کہ آپ لوگ برطانیہ (U.K) میں بڑی مقدار میں پیدا ہونے والی ویسٹ (WASTE) کے متعلق کیا محسوس کرتے ہیں - اس سروے سے مہیا کردہ معلومات سے ان منصوبوں کو مدد ملے گی جن کے تحت گھر کی روزمرہ کی ویسٹ پھینکی جانے کی بجائے دوبارہ استعمال کرنے کے قابل بنایا جا سکے ۔

اس سلسلے میں آپ سے کچھ سیدھے سادھے سوالات پوچھے جائیں گے - آپ سے درخواست ہے کہ آپ اس معاملے میں ہمارا تعاون کریں ۔

اس سروے کے نتائج اس سال (1979) کے آخر میں شائع کیے جائیں گے - آپ کا نام یا پتہ شائع نہیں کیا جائے گا - ہماری ٹیم کا ایک رکن آئندہ چند دنوں میں آپ کے گھر آئے گا جو کہ اپنا شناختی کارڈ دکھا کر مزید معلومات آپ کو فراہم کرے گا ۔

شکریہ!

آپ مزید معلومات مندرجہ ذیل حضرات سے کر سکتے ہیں ۔

Dorothy C. Mercer ڈوروتھی مرسر
Research Officer

Appendix XII

QUESTIONNAIRES USED FOR THE
CONSUMER SURVEYS IN LEICESTER AND BLACKBURN

QUESTIONNAIRE USED FOR THE CONSUMER SURVEY IN LEICESTER

Part I

1A Soft Drinks

(1) Do you or your family buy carbonated (fizzy) soft drinks in bottles or cans? Where carbonated soft drinks include such drinks as lemonade, coca cola, tonic water, bitter lemon, lucozade etc., like the drinks shown on these two cards A + B.

Yes..............

No...............

If NONE of these bottles bought, move on to Question 4.

	Bottle No. Soft drinks							
	1	2	3	4	5	6	7	8
(2) Do you ever buy any of these bottles? If yes, then ask whether (b), (c) or (d), either:								
(a) Never) tick answer given (b) Rarely) by each member of (c) Occasionally) the HH replying - (d) Frequently) use subscripts i.e. $\checkmark_1$ $\checkmark_2$ $\checkmark_3$								
(3) Can you tell me which of these bottles are returnable (RB) or non-returnable (NRB)? Or if you do not know whether the bottle is a returnable or a non-returnable (DK)? State each member of the HH's reply of RB, NRB or don't know (DK).								
HH member No. 1								
HH member No. 2								
HH member No. 3								

(4) Do you buy any other brands of carbonated soft drinks in returnable bottles? If so, can you give the names of these brands.

- YES/NO.
- BRANDS BOUGHT ....

....

....

(5) Of these returnable bottles that you buy (refer back to answers to questions 2 + 4), what proportion do you normally return to the shops, pubs, off-licence?

	Other RB's bought	State return rate for the specific RB's that HH buys			
		1	4	5	8
Either - All					
75%/most					
50%					
25%/few					
NONE					
Don't know					
Other replies specify					

1B Beer and Cider

(6) Do you or your family ever purchase any beer or cider in bottles or cans?

Yes ....

No ....

If yes - go to Question 7

no - move on to question 11 (If answer to both Questions 1 and 6 is no - finish interview).

Show Cards C & D

	Bottle No.							
(7) Do you ever buy any of these bottles. If yes - then how often (b), (c) or (d)?	9	10	11	12	13	14	15	16
(a) Never) tick answer given by								
(b) Rarely) each member of HH								
(c) Occasionally) replying								
(d) Frequently) i.e. ✓1 ✓2 ✓3								

(8) Can you tell me which of these bottles are returnable (RB) and which are non-returnable (NRB) or if you do not know whether the bottle is returnable or non-returnable (DK). State (RB), (NRB) or (DK) for each member of HH replying.

HH member No. 1

HH member No. 2

HH member No. 3

(9) Do you buy any other brands of beer and cider in returnable bottles?

Yes ....

No ....

Brands Bought ....

....

....

(10) Of these returnable bottles that you buy, refer back to replies to Questions 7 + 9, what proportion do you return to the shops?

Tick return rate for specific RB's bought by each HH

		Other RB's Bought	Bottle No. 9	11	12	13	14	16
Either - All	) Tick appropriate category and use							
75%/most	) subscripts if different							
50%	) replies given by different							
25%	) members of HH							
NONE	)							
Don't know	)							
Other replies specify	)							

Part II

(11) Why do you return these bottles?
State reasons given.

(12) Is there any particular reason why you do not return these bottles?

(13) What do you think would encourage you to return more bottles?
Specify factor(s) stated:

If HH's state 'easier return' then prompt for in what way easier and note down reply.

(14) Do you know the Deposit level on the ten returnable soft drinks, beer and cider bottles shown in these four cards?

Beverage	Card	Bottle No.	HH No. 1	Reply of HH HH No. 2	HH No. 3
Soft Drinks	A	1			
		4			
	B	5			
		8			
Beer	C	9			
		11			
		12			
Cider	D	13			
		14			
		16			

(15) Talking of Deposits, what is the level of deposit that would <u>just</u> make it worthwhile <u>for you</u> to return bottles?

(16) How easy or difficult do you think it is for you to return bottles to the shops, pubs or off licences?

		A	B
i)	very difficult	....	....
ii)	difficult	....	....
iii)	a little difficult	....	....
iv)	no trouble/easy	....	....
v)	others - specify	....	....

A = Normal reply.

B = Reply which may be given by HH, in addition to (or instead of) A. For abnormal conditions don't ask for B, but note any such reply given and specify the abnormal conditions stated, e.g.:

- random purchase
- holiday
- other.

If answer to Question 16 is easy, then ask Question 17.

(17) In what way do you find it easy to return bottles?

State factors given.

If answer to Question 16 is difficult (i.e. (i) - (iii)), then ask Question 18, "In what way is the returning of bottles to the retail outlets difficult for you?" State factors given.

- If retailers' attitude is cited then find out in what way retailer's attitudes/ actions creates problems.
State reasons given.

- As a result of these difficulties, did you give up the attempt to return the bottles? Yes .... No ....

(19) What factors would make it easier for you to return (more) bottles?
State factors given.

Finally there are just a few general questions I would like to ask you about your household so that we can group these useful responses of yours into the various household classifications.

(1) Area ....

(2) Type of house - Terrace ....
Semi ....
Detached ....
Flat - multi-storey ....
-<4 floors ....

(3) Sex of respondent
1 ....
2 ....
3 ....

(4) Age of respondent

	1-16	17-30	31-50	51-60	61+
1					
2					
3					

(5) Number in household .... Adults
.... Children

(6) Occupation in household
1 ....
2 ....
3 ....

Thank you for your co-operation. It has been most interesting to talk to you. The results of the survey will be useful to our research at Leicester University and perhaps also the Government in its review of the returnable/non-returnable bottle question. The results will be ready next month and will be announced in the local newspaper and on Radio Leicester, if you are interested in seeing what comes out of the study.

Your impression DON'T ASK	(Interested	....
	(Indifferent/can't tell	....
	(Not interested	....

Time finished ....

Length of interview ....