

**COST-BENEFIT ANALYSIS OF THE
PETROCHEMICAL INDUSTRY:
THE CASE OF SAUDI ARABIA**

by

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PH.D. 1991

*Thesis Submitted for the degree of
Doctor of Philosophy
at the University of Leicester*

**DEPARTMENT OF ECONOMICS
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ABSTRACT

COST-BENEFIT ANALYSIS OF THE PETROCHEMICAL INDUSTRY THE CASE OF SAUDI ARABIA

BY

Abdulaziz S. Almashari

The aim of this thesis is to examine a cost-benefit analysis of the petrochemical industry comparing the costs of production, such as capital cost, labour cost, etc. in Saudi Arabia, and show the degree of its competitiveness in the international market. Also it discusses and evaluates the industrial development process in Saudi Arabia. The labour shortage and the marketing problems of the petrochemical products will be examined and solutions to these problems will be given.

This research started by dealing with the theoretical background of the development planning. Various sources of energy literature have been reviewed, describing the role that hydrocarbon resource exploitation played in the Saudi development plans. Its objectives are to identify and understand the development problems, its strategies, objectives and plans of the Saudi government by paying attention to the role of the oil and gas resources and the country opportunities for diversification of the economy and decreasing dependence on crude oil and to use their limited resources more efficiently.

Various procedural approaches were considered for evaluating development projects in order to increase the effectiveness of the development programs in Saudi Arabia. These include: improving the people's welfare, increasing national income, expanding the country's absorptive capacity and shifting to a renewable resource base.

The petrochemical industry is the most feasible industry to be established in Saudi Arabia at this time. It would provide the country with the best alternative for steady economic growth with decreasing emphasis on the export of oil.

The thesis will try to prove that the development of the petrochemical industry in Saudi Arabia is an adequate economic project, only if the major constraints such as labour shortage and marketing and profitability on the international market for petrochemical products can be overcome or at least minimised.

ACKNOWLEDGEMENT

This thesis is the final work of the researcher; however, it also represents a collective undertaking by the author and others who contributed directly or indirectly to its successful completion.

It is my privilege and honour to have Professor P M Jackson as my Supervisor. It is with pleasure that I acknowledge his great help, criticism, suggestions and support. He devoted a large portion of his valuable time and effort with much patience to this work. His professional direction and guidance throughout the study contributed greatly to the maturation of my academic and intellectual skills, for which I am indebted. Professor Jackson's professional and intellectual capabilities have always been the centre of my respect and admiration.

I am indebted to my Sister, Brothers and friends for their support and encouragement.

Sincere thanks to Ms Pat Greatorrex and Miss Joanne Gillespie, who spent long hours typing the thesis. They really did a marvellous job.

Last, but by no means least, I would like to thank my wife and my children, Meshal and Bandar,

This thesis would never have been completed without their assistance, understanding, encouragement and patience. To her and my children, I very much appreciated their sacrifices.

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ABBREVIATIONS

ACM - Arab Common Market

AEV - Arab Economic Unity

ARAMCO - Arabian - American Oil Company

ARI - Accounting Rate of Interest

BTU - British Thermal Unit

CIF - Cost Insurance Freight

CMEA - Council for Mutual Economic Assistance

CPO - Central Planning Organisation

CV - Compensating Variation

EEC - European Economic Community

EFTA - European Free Trade Association

EPA - Environmental Protection Agency

EV - Equivalent Variation

FOB - Free on Board

GCC - Gulf Cooperation Council

GDP - Gross Domestic Product

GNP - Gross National Product

GOID - Gulf Organisation for Industrial Development

GSP - Generalised System of Preference

IBRD - International Bank of Reconstructions and
Development

ICF - Investment Conversion Factor

IRR - Internal Rate of Return

LAFTA - Latin American Free Trade Association

LDCs - Less Developed Countries

LNG - Liquified Natural Gas

LPG - Liquified Petroleum Gas

MIE - Ministry of Industry and Electricity

MOFNI - Ministry of Finance and Natural Economy

MTBE - Methyl Teriary Butyl Ether

NB - Net Benefit

NG - Natural Gas

NPV - Net Present Value

OAPEC - Organisation of Arab Petroleum Exporting
Countries

OECD - Organisation for Economic Cooperation and
Development

OPEC - Organisation of the Petroleum Exporting
Countries

Petromin - Petroleum and Mineral Organisation

PIF - Public Investment Fund

PV - Present Value

SABIC - Saudi Arabia Basic Industries Corporation

SAFCO - Saudi Arabian Fertilizer Company

SCF - Specific Conversion Factor

SIDF - Saudi Industrial Development Fund

SR - Saudi Riyal (\$1 = SR 3.75)

SWR - Shadow Wage Rate

UAE - United Arab Emirates

UNIDO - United Nations Industrial Development
Organisation

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Before the unification of Saudi Arabia in 1932, the country was one of the poorest countries in the world. Economic activity was confined to livestock raising, production of simple tools by craftsmen and primitive agriculture. The main source of foreign exchange was the overseas movement of pilgrims visiting the holy places in Mecca and Medina.

In 1933, the government of Saudi Arabia granted a concession to Standard Oil of California for oil exploration. By March 1938 oil was discovered in commercial quantities, since then oil was the main source of income. The production of oil increased rapidly from 60 million barrels in 1946 to 200 million barrels during 1950 and the oil revenues increased from \$103 million in 1948 to \$73,000 million in 1981⁽¹⁾.

The world oil supply was disrupted by the Arab-Oil embargo in 1973, sending the oil prices skyrocketing. The price of oil increased from \$2.10

(1) Ali D. Johany The Saudi Economy Yesterday Performance and Tomorrow's Prospects ed. by El.Mallakhs in "Saudi Arabia: Energy, Development Planning and Industrialisation" 1982, p.1

per barrel in the first quarter of 1973 to 13.65 per barrel in the fourth quarter of the same year⁽¹⁾. Also the oil production increased from 6.033 mpbd, in 1972 to 7.59 mpbd in 1973, and the total revenue from oil sales as a percentage of total revenues increased from 87.1 percent in 1971/72 to 97.3 percent in 1973/74.⁽²⁾

Saudi Arabia has a limited absorptive capacity, and become known as a capital-surplus economy. The Saudi economy has been dependent on oil revenues which is insufficient to meet the requirements for the overall development of the economy. This dependence on oil has been cited as the certain cause of the Saudi future vulnerability when the oil resource is gone, so they need to transform the oil wealth into productive assets, and to achieve real growth especially in the non-oil sectors. The government main concern is to decrease dependence on crude oil and use their limited resources more efficiently in order to diversify the economy. Hence the diversification process will provide protection, not only for coming generations when the oil is gone, but also for the present generation, against the declining the unstable oil revenues.

(1) Facts and Figures (1970-1982), Ministry of Planning, p.125.

(2) Facts and Figures (1970-1982), p.76

The oil revenue declined in recent years, because of the recent oil glut in the international market has caused oil prices to decrease. The reasons for the oil glut can be summarised as follows:

1. The worldwide supply of oil has increased in both developed and developing countries, and the export of oil increased by other non-OPEC countries, such as Great Britain, Mexico and Norway.
2. The industrial countries built up huge stockpiles of oil when the price of oil was low, and start using these reserves when the prices go up.
3. The demand for oil has been affected by the world conservation in energy consumption.
4. The world recession has affected the world demand for all kind of commodities, including oil.
5. The use of alternative ways of energy such as wind and solar energy.

Since the Saudi government is the sole recipient of oil revenue, it increases its expenditures on the non-oil sector to diversify exports and thus hedge against the uncertainty concerning the level and the

amount of foreign exchange earnings. The government pattern of expenditure correlates with a set of priorities stated in the development plans. The first five year plan (1970-1975) was a learning experience, especially with respect to the rising of inflation that resulted from the unsolved bottlenecks that limited the country absorptive capacity⁽¹⁾. The second plan period (1975-1980) was one of considerable progress inflation was reduced, absorptive capacity was increased, infrastructure was improved, and favourable growth rates were attained. The third development plan (1980-1985) was to deal primarily with the areas of manpower, efficiency and participation. The fourth five year plan (1985-1990) was to develop human resources, raise educational standards, reduce dependence on oil, develop mineral resources and achieve economic and social integration between the Gulf countries⁽²⁾.

The government calls for the establishment of two industrial cities at Jubail and Yanbu. The investment in the industrial complex at Jubail alone was approximately \$40 billion in the late 1970s, this complex includes petrochemical projects, steel plants, and fertiliser plants, the largest industrial complex

(1) R. El-Mallakh Saudi Arabia Rush to Development, 1982, p.212.

(2) Caroline Montagu Industrial Development in Saudi Arabia, 1987, p.12

in the world history.⁽¹⁾ The petrochemical industry was selected because it is a capital intensive and depends on natural gas as both fuel and raw material. Also it is entirely linked to the international market to import industrial input such as machinery, technology and skilled-labour, and to export the petrochemical products. The main objective of the government is to reduce oil dependency and diversify exports by industrialisation through the establishment of export oriented projects.

For the Saudi petrochemical industry to be viable in the long-run it depends significantly on its ability to become a relatively low-cost producer when the government subsidies are eliminated. Currently the petrochemical industry is heavily subsidised by the government. The government supplies utilities to the industry at a cost much below the actual cost. Also it provided financial capital at an interest rate far below that of the local commercial banks.

This thesis will attempt to show a study of cost-benefit analysis comparing the costs of production, such as capital cost, labour, etc. in the Saudi petrochemical industry to those of other international

(1) Tim Niblock State, Society and Economy in Saudi Arabia, 1982, p.238.

producers. Taking into consideration the characteristics of the petrochemical industry, the Saudi entrance into this industry can be justified as a good strategy, because Saudi Arabia has many benefits in entering the petrochemical industry, such as the low cost of raw materials, location, another source of income, etc. Even though there are other cost disadvantages which could play an important role in determining the level of those benefits such as capital cost, labour cost which is higher in Saudi Arabia than other international producers.

The petrochemical industry is the most feasible industry to be established in Saudi Arabia at this time. It would provide the country with the best alternative for steady economic growth with decreasing emphasis on the export of crude oil. The Saudi petrochemical industry faces major domestic constraints such as the shortage of labour and external obstacles such as marketing and profitability on the international market for petrochemicals. However, these constraints have relatively better prospects for solution than the constraints faced in either the agricultural or non-oil natural resource sectors. The increase foreseen in the value added by crude oil plus the great variety of petrochemical products, would insure less income dependence on crude oil, which is the main objective of the

diversification process being attempted by the government of Saudi Arabia. Although there is a clear relationship between changes in the oil and gas market and those in the petrochemicals market, the large effect in this relation would provide more stability to the income generated from petrochemicals and will give a better chance of making necessary adjustment.

This thesis will try to prove that the development of the petrochemical industry in Saudi Arabia is an adequate economic project, only if the major constraints such as labour shortage and marketing and profitability on the international market for petrochemical products can be overcome or at least minimised.

1.2 Objectives of the Study

This thesis objectives is to identify and understand the development problems, its objectives, strategies, and plans of the Saudi government by paying particular attention to the role of the oil and gas resources and the country opportunities for diversification of the economy and decreasing dependence on crude oil and to use its limited resources more efficiently.

Another main objective is to suggest an appropriate development strategy by the implication of

project evaluation, for a country with capital abundant, labour scarce such as Saudi Arabia.

The final objective of this thesis is to examine a cost-benefit analysis of the petrochemical industry and the degree of its competitiveness in the international market. Also to discuss and evaluate the industrial development process in Saudi Arabia. The Marketing problems of the petrochemical products will be examined and solutions to these problems will be given.

1.3 Methodology

This thesis deals with the viability of the petrochemical industry in Saudi Arabia. The industrial viability depends on the ability of the Saudi international competitiveness in the production of petrochemicals, and the ability of this industry to be self sustaining and self expanding on the long-run.

A cost-benefit analysis will examine the degree of international competitiveness and compare the cost of petrochemical production in Saudi Arabia to other competitors. The industrial development process in Saudi Arabia is discussed and evaluated.

The thesis also overviews the current project evaluation methods in use today. It involves

surveying the economic diversification in Saudi Arabia and emphasize opportunities and constraints. An analysis procedure has been suggested to incorporate these constraints. The economic logic in selecting the large scale petrochemical industry because: Saudi Arabia has huge amounts of oil and gas and endowed with a financial surplus capital and low absorptive capacity, whereas the petrochemical industry is an energy and capital intensive industry. Also it is expected that the petrochemical industry will achieve the Saudi goals to diversified their economy.

The profitability of the petrochemical industry in the future is surrounded by great uncertainty; this results from price uncertainty, unknown growth rate of world economies, changes in terms of trade and political consideration. In testing the profitability of a project in the long-run, economists provided two economic criteria: the Net Present Value (NPV) and the Internal Rate of Return (IRR). However the data required for the calculation of the NPV are very difficult to obtain.

1.4 Data Limitations

In spite of an ever increasing volume of published material on the Saudi Arabian economy, it is still extremely difficult to present accurate and comprehensive picture of the industrial production in

Saudi Arabia.

The confidentiality of information related to many industries was one of the problems that prevented me from obtaining data on production cost in the industrial sector. The data related to the petrochemical industry was so scarce and so confidential that it was impossible in many cases to obtain even rough estimations.

The majority of the data used in this thesis was obtained from sources such as the publication of the United Nations, the Organisation of the Petroleum Exporting Countries (OPEC), the Gulf Organisation for Industrial Development (GOID), the Organisation of Arab Petroleum Exporting Countries (OAPEC), British Petroleum Corporation, and other oil corporations.

The reliability of data was questionable in the case of non-official sources. A great amount of data published by these sources is regarded as inaccurate, because the type of data obtained through this method varied from one source to another and no explanation is given to method or sources of information used for estimating such figures.

Since obtaining data related to the Saudi economy was very difficult. In some cases therefore I used a

theoretical rather than statistical approach of analysis.

The official sources used in this thesis were mainly the publications of Ministry of Finance, the Ministry of Planning, the Ministry of Industry and Electricity. Unfortunately, the information was limited and of little benefit to the analysis.

1.5 Structure of the Study:

This thesis is composed of ten chapters. The second chapter, will be devoted to a discussion of the national development planning, its definition, its importance in the less developed countries, and briefly describing its various aspects, characteristics and strategies. Also in this chapter the opportunities and constraints of industrial development will be discussed.

Chapter three, discusses the role of oil and gas in the development plan of Saudi Arabia, providing an overview of oil and gas as sources of energy and income, also it shows the role of oil and gas utilisation in various economic activities.

Chapter four, will examine the various issues related to the use of natural resources as a development strategy, based on utilising their

nonrenewable natural resources.

Chapter five, discusses the petrochemical industry, its characteristics, the share of industrial countries in petrochemical industry and the role of developing countries.

Chapter six, discusses the project evaluation which occupies an important place in the economic development literature. Several international organisations will be discussed such as the Organisation for Economic Corporation and Development (OECD) and the United Nations Industrial Development Organisation (UNIDO). Also the World Bank approach will be examined. This chapter also deals with the project analysis concepts for Saudi Arabia and the project contribution to the national income.

Chapter seven, is devoted to the discussion of the Shadow Prices, with specific reference to the basic principles in the Little and Mirrlees approach. It shows the main building blocks of this approach to social cost and benefit analysis.

Chapter eight, deals with the cost-benefit analysis, it deals with the application of the tools of the measurement of welfare change to a particular sort of problem. It shows the major measurement

problems associated with the government projects, and the appropriate investment criteria. The problem of risk and uncertainty will be discussed. This chapter will examine the experience of Saudi Arabia petrochemical industry and show the major cost and benefit of this industry, also the possibilities of other alternatives will be discussed, and solutions for the cost disadvantage of the petrochemical industry will be given to increase the productivity level of workers.

Chapter nine, discusses the marketing of petrochemicals and the difficulties of access to the world market for Saudi petrochemical products. Possible measures for expanding access to the world market will be examined.

Chapter ten reports the summary and final conclusions of the thesis.

CHAPTER 2

DEVELOPMENT PLANNING IN SAUDI ARABIA

2.1 INTRODUCTION

Development planning in Saudi Arabia was initiated by the government and development plans have been prepared in order to take advantage of the new and massive resources and to finance economic and social progress. Oil is the major source of income and since it is a nonrenewable resource, the national utilisation of this resource for ultimate goal of creating a self-sustained economy which can replace this dependence on oil in the future becomes very eminent and development planning is considered to be the best way to do that.

It is appropriate to talk about the development planning in general, its definition, history, importance, characteristics, etc. Then later in this chapter come back and discuss the development planning in Saudi Arabia.

Since the end of the Second World War, numerous countries, especially the less developed countries (LDCs), began to realize the complexity of their economic problems and to search for solutions to these problems. Shaner stated that during this era economic development emerged as a national planning

technique to achieve its objectives⁽¹⁾. Tinbergen indicated that development planning became an important part of the state activities and its techniques have improved and gained wide acceptance in the postwar era.⁽²⁾

2.2 Definition of Development Planning

The literature contains several definitions of development planning. Todaro defines it as:

.... a deliberate governmental attempt to coordinate economic decision making over the long run and to influence, direct, and in some cases even control the level and growth of the nations principal economic variables (income, consumption, employment, investment, savings, export, imports, etc.) in order to achieve a predetermined set of development objectives.⁽³⁾

Development planning is also defined as:-

.... a process involving the application of national system of choices among feasible courses of investment and other development possibilities based on a consideration of economic and social costs and benefits.⁽⁴⁾

Adelman defines economic development as a process by which an economy in a stationary state attains a significant and sustained rate of growth in per capita

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- (1) Shaner, W. W., Project Planning for Developing Economics (New York: Praeger), p.13
 - (2) Tinbergen, J. (1967) Development Planning (New York: McGraw - Hill Book Company), pp. 43-49
 - (3) Todaro, M. P., (1981) Economic Development in the Third World 2nd Edition (New York: Longman) p. 430
 - (4) Waterston, A. (1970) "A Hard Look at Development Planning" in T. Morgan and G. W. Betz (eds) Economic Development: Readings in Theory and Practice (Belmont CA: Wadsworth Publishing Co., Inc. p.401

income as a persistent long-run feature.⁽¹⁾

The Adelman definition identifies development with economic growth; however, some development economists seek a distinction between different types of growth.

For example, Kindleberger states, "Economic growth means more output, and economic development implies both more output and changes in the technical and institutional arrangements by which it is produced".⁽²⁾ Meier and Baldwin define economic development as "a process whereby an economy's national income increases over a long period of time".⁽³⁾ Kennessey draws the distinction between development planning, which refers to the socioeconomic process as a whole, and economic development, which focuses on only the economic aspects.⁽⁴⁾ Waterston defines development planning as "an organized, intelligent attempt to select the best available alternatives to achieve specific goals". Waterston also classifies economic development as being anticyclical, ie. seeking full employment of

(1) Adelman, I. (1971) The Theories of Economic Growth and Development (Stanford: Stanford University Press)

(2) Kindleberger, C P (1965) Economic Development 2nd Edition (New York: McGraw-Hill Book Company p.3

(3) Meier, G. M. and Baldwin, R. E., (1957) Economic Development Theory, History, Policy New York: John Wiley and Sons, Inc.) p.2

(4) Kennessey, Z. (1978) The Process of Economic Planning (New York: Columbia University Press) p.33

resources for social and economic progress. This type of planning is practiced in advanced economies. Developmental planning practiced in the LDCs. seeks better utilization of available resources to achieve national objectives.⁽¹⁾

2.3 Brief History of Development Planning

Economic development activities became popularized when, in 1776, Adam Smith published The Wealth of Nations and discussed the sequencing of the task. Later, economic development appealed to German writers of the nineteenth century. List (1844) discussed the various stages of economic growth countries typically experience. Hildebrand (1864) wrote about the financial aspects of economic growth. Bucher (1893) discussed what he called 'town planning', which, to a certain extent, is now termed regional planning. During the same era similar activities in England and the United States were led by writers like Ashley, Unwin, and Gras.⁽²⁾

As World War II ended, a widespread need for planning was felt. Waterston states that the recovery programs like the Marshall plan required each

(1) Waterson, A., (1965) Development Planning: Lessons and Experience (Baltimore: the Johns Hopkins University Press) pp.15-16.

(2) Meyer, G. and Baldwin, R. E, (1957) Economic Development: Theory, History, Policy provide an extensive discussion of the history of development

participating country to prepare comprehensive four year annual plans surveying their resources and their utilization.⁽¹⁾ Another reason for interest in development planning pointed out by Shaner was the creation of the United Nation and its various agencies that offer help to less developed countries.⁽²⁾

2.4 The Importance of development Planning in the LDCs

Developing countries share common characteristics, summarized in Shaner as: (1) a predominantly agricultural sector which used primitive methods; (2) a high rate of population growth and low life expectancy; (3) a high rate of migration from rural to urban areas, which exerts pressure on municipal services, which in turn cannot grow rapidly enough to meet the needs of newcomers; (4) widespread unemployment; (5) a shortage in the supply of foreign exchange (6) greater investment in land than manufacturing; (7) Vulnerability to international forces; (8) governmental difficulty in raising sufficient funds through taxation; (9) inadequate infrastructure; and (10) high inflation.⁽³⁾ These characteristics lead the LDCs to share a common ground of several social and economic problems, such as a low standard of living, low productivity, high unemployment, etc. To alleviate these conditions,

(1) Waterston, p.31

(2) Shaner, p.13

(3) Shaner, p.9

decision makers in the LDCs must coordinate the efforts of various branches of government to deal with critical economic sectors to increase their productivity and participation in a comprehensive national development effort. This process emphasizes the importance of development planning and its implementation in the LDCs. Development planning is needed in developing countries to achieve their various objectives; however, some believe that the main reason for planning in some LDCs is to obtain foreign aid rather than to assume the responsibilities of development⁽¹⁾. Their case may not be true in some OPEC countries, which have surplus financial assets. Their planning activities are directed toward achieving their specified development targets.

2.5 Characteristics, of Development Planning

A national development plan has been defined as:

"..... a systematic and integrated program of action covering a definite period of time, approved or sponsored by the state to bring about a rational utilization of resources to achieve certain national targets."⁽²⁾

Development plans differ from one country to another due to the diversity of social, political, economic, natural, and human resources of each

(1) Veron, R. (March 1966) "Comprehensive Model Building in the Planning Process: The Case of the Less Developed Countries" The Economic Journal (London: Macmillan Limited) p.59

(2) Qayum, A. (1975) Techniques of National Economic Planning (Bloomington, IN: Indiana University Press), p.4

country. However, the basic characteristics of those plans to a certain extent remain the same. These characteristics can be stated as follows:

2.5.1 Definition of Plan Objectives

The development plan usually starts from the political views of the government; however, when the plan begins to materialize, the first step is to define the objectives of the plan as it relates to the country's economy, whether it is a comprehensive or regional development plan. National objectives vary; they may be social (eg. to achieve employment, equitable income distribution, improved health, and widespread education), or they could be economic (eg. to increase the growth rate and diversify revenue sources through industrialization).

2.5.2 Setting out the Development Strategies

After the national objectives are defined and the country's various resources are surveyed, a strategy to achieve the plan's targets should be set out. This strategy consists of a preferred way to achieve national goals, taking into consideration any contingencies that might develop during the plan's execution.

2.5.3 Setting Targets and Guidelines

Targets are an essential element of any

development plan. Qayum stated that it is inconceivable to have a plan without targets; he also indicated that the system of setting plan targets varies from one country to another according to the form of government and socioeconomic structure.⁽¹⁾ The development plan needs certain measures and guidelines to execute plan strategies and to achieve targets as well as to administer day-to-day decisions.

2.5.4 Duration of the Plan

The development plans are of three basic types, according to their length of time. They can be short term, covering a period of one or two years. The second type is the medium-term plan, which is usually conducted over a four or five year period. The third type is the long-term plan, which is executed over a period of more than seven years.⁽²⁾

A plan's duration is dictated by various circumstances. For example, administrative contingencies may alter a plan's usefulness resulting from an inexperienced administrator. Political duration may coincide with a government leader's term in office, and so on.

(1) Qayum, A. (1975) Techniques of National Economic Planning (Bloomington, IN: Indiana University Press, p.15

(2) Waterson, pp. 121-125

2.5.5 Implementation

The final phase of the planning process is to implement the designed plan. Implementation requires that existing laws and policies do not impede the execution of the implication process, allowing it to proceed with as few significant obstacles as possible. Colm summarizes the importance of implementation:

"The final element of a well-conceived plan is the provision for its implementation. This includes the organization of the planning function and its administrative relationship with the chief executive, the policy-making and operating departments of the government, and the Legislature; the assignment of responsibilities of carrying out its component programs, the relationship of the plan to national budget; the roles of the fiscal and monetary authorities; the provisions for progress reporting and evaluation; and the selection and training of planning personal.⁽¹⁾

The experiences of some Gulf states when they implemented their industrial plans can be cited as examples of how Laws can sometimes create unnecessary obstacles. Due to their manpower shortage these countries had to import foreign labour. However, the laws of these countries prevented foreign labour from changing jobs without prior approval from the Labour Office. Such regulation could hinder labour productivity since a worker could be prevented from moving to the job where he could be most productive.

(1) Geiger, T. and Colm, G. (1962) "Country Programming as a Guide to Development" in Development of Emerging Countries (Washington, D.C.: Brookings Institution) p.51

2.6 Development Strategies

Strategy has been defined as the route selected to reach long-term objectives.⁽¹⁾ However, as Lewis has suggested, there is no single unifying theme underlying discussions of development strategies, but instead a country must judge which issues are important in a particular setting.⁽²⁾ The issues of strategy which the OPEC countries have considered since the middle 1960s are: (1) to be more than mere exporters of a single commodity, oil; and (2) to diversify their national income sources.⁽³⁾ The OPEC Secretary General went further in defining OPEC strategies as being: (1) to utilize an indigenous raw material, (2) to help in learning processes and acquiring technology, (3) to reduce heavy dependence on oil exports as a source of foreign exchange, and (4) to invest in the development of human resources.⁽⁴⁾

To implement these strategies, the OPEC countries turn to industrialization, "downstream"

(1) Schiavo-Campo, S., and Singer, H. W., (1970) Prospects of Economic Development (Boston: Houghton-Mifflin Co.,) p.8

(2) Lewis, W. A., (1966) Development Planning: The Essentials of Economic Policy (New York: Harper and Row,) p.26

(3) Turner, L., and Bedore, J. (1979) Middle East Industrialization: A Study of Saudi and Iranian Downstream Investments (New York: Praeger) p.1

(4) Remarks by A. M. Jaidah, OPEC Secretary General, OPEC Seminar on Downstream Operation in Vienna, Austria, October 9-11, 1978

industrialization in particular, to achieve their national objectives, which are designed to achieve a sustainable economic growth. However, because industrial development requires certain constraints which serve to hinder the above mentioned goals.

2.7 Motivation for Industrial Development by OPEC Countries

Ali Khalifa Al-Sabah, the oil Minister of Kuwait, addressed an OPEC seminar on downstream operations and summarized the motivation for going downstream:

- (a) "the petroleum industry being energy intensive; the energy cost is made lower in the OPEC countries, either through gas that was going to be wasted anyway, or, at the very least, by fuel oil that did not incur the additional cost of transportation;
- (b) the oil industry being capital intensive ... it is extremely advantageous to undertake operations now rather than during the next economic cycle, when every concern will be modernizing, and costs of capital will soar. The OPEC countries with their cash surpluses are now well placed to take advantage of this;
- (c) having the flexibility which results from being mid-way between a number of major markets".⁽¹⁾

The diversification of national revenue and eliminating major dependence on the export of crude oil, which is a depletable resource, were further motivation for industrialisation in the OPEC

(1) Proceedings of the OPEC Seminar on Downstream Operations in OPEC Member Countries - Prospects and Problems (Vienna, Austria: October 9-11, 1978, p.10

countries, as expressed by the OPEC Secretary General:

"The present well being is derived from the export of a single raw material, finite natural supply, a resource which will be exhausted within three or four decades."⁽¹⁾

Development of human resources could be the motives for industrial development activities in the OPEC countries, as it is often expressed by OPEC officials.

2.8 Constraints to Industrialization

The industrial ventures considered by OPEC countries are not expected to become economically viable without encountering certain constraints. These constraints must be taken into consideration when analyzing proposed industrial projects. Although these constraints may differ in their sources, they will all hinder industrial development if they are not properly dealt with. These constraints relate to population (eg. market, manpower, and absorption capacity) and to resources (eg. the degree of availability of oil and gas). These impediments have been the primary concern of planners in OPEC countries. The OPEC Secretary General expressed this concern:

(1) Ibid, p.10

"..... vast divergences can be observed in our various member countries with regard to their economic and political structures. They vary according to their history and experience in the oil industry, the size of their population, ... the availability of their oil and gas reserves and ultimate hydrocarbon potential. All of these factors modify and constrain the opportunity for development....."(1)

2.9 Opportunity for Industrialisation

An economically vital industry was born with the discovery of oil in the nineteenth century. The oil industry spread rapidly almost all over the world, and with it many economic, social and technical changes took place in those parts of the world where oil had been found. These changes offered certain opportunities for industrialisation programs to be carried out, especially in the OPEC countries, which prior to the discovery of oil lagged according to most economic measures.

2.9.1 Large Influx of Capital

Oil exports play a predominant role as a source of foreign exchange in OPEC countries. Before the discovery of oil they suffered from a severe shortage of foreign exchange. As will be discussed in the next chapter, the availability of accumulated capital from oil exports played an important role in the industrial development programs of OPEC countries. The availability of capital alleviated the financial

(1) Ibid, p.19

constraints which usually hinder development activities.

2.9.2 Transfer of Technology

The oil industry is technology intensive. When the giant oil companies began exploration for oil in the Third World countries at the beginning of this century, they carried oil technology with them to those countries. The influx of technology offered the local manpower opportunities to learn new skills in the new technologies needed by the oil industry. The oil companies played another role in the communities where they operated: for example, the Arabian American Oil Company (ARAMCO), which operates in Saudi Arabia, established a technical assistance division, its function stated as:

"It gives technical and other assistance to government agencies, municipalities and private business firms in the development and improvement of communities and local industries. It is prepared to provide engineering, technical and economic advice, to assist in planning and making specifications, and to aid in the procurement of materials and equipment. In some instances it guarantees bank loans when local industries need financing".⁽¹⁾

The training gained through the process of acquiring new, oil-related technologies helped to support initiation of the industrialization process.

(1) ARAMCO Handbook (1964) (Dhahran Saudi Arabia: Arabian American Oil Company) p.216

2.10 Factors for Selecting a Development Strategy

The road to development is not always accessible to every country; each has its own resource endowments and other factors that might prevail in one country but not in another. These factors dictate the type of development strategy that the country's planners and decision makers will adopt. Generally, certain factors should be considered when selecting any development strategy. They are briefly summarized as follows:

2.10.1 Human Resources

Countries vary. Some are over populated, while others have sparse population. The human resource factor is an important one when designing an economic development strategy, because the development activities are intended for and carried out by human beings. Okun and Richardson stated, "The Human Factor, unlike any other in the productive process, is not only an instrument of economic activity and growth, but is itself the rationale for such activity in the first place".⁽¹⁾

The human resource factor influences the nature of the development programs; countries with large populations usually tend to select labour-intensive

(1) Okun, B. and Richardson, R. W., (1961) Studies in Economic Development (New York: Holt, Rinehart and Winston, Inc.) p.244

industries. On the other hand, countries with abundant capital and small populations are normally tilted toward capital - intensive projects. These situations are considered in the OPEC countries, whose industrial development programs will be discussed in the next chapters.

2.10.2 Natural Resources

As with human resources, the type and quantity of the country's available natural resources can influence the type of development activities selected. These resources range from nonrenewable ones like oil and gas to renewable ones such as fisheries and forests. Countries with abundant water, for example, may build their development strategies on the utilization of water, in agricultural projects and power generation. Likewise, countries with sizable oil and gas reserves may exploit these resources and use them for power generation and downstream processing industries. Where scenic places and moderate weather abound, the strategy will probably tend to encourage tourism.

2.10.3 Technology

Technology capability is another factor that affects the strategist's selection. As will be discussed in depth later, technology is one of the determinants of an economy's absorptive capacity. The

development strategy of any developing country must incorporate the issues of lack of technology into the comprehensive planning process. Enhancement of technology transfer will help to stimulate the economy and speed its growth, given the appropriate strategy.

2.10.4 The Availability of Capital

Capital is an important ingredient in the recipe for development. A capital shortage constrains the development process. On the other hand, a capital surplus may highlight an absorptive capacity problem. The shortage or excess of capital is a problem which should be entrusted to strategic planners to design plans to accommodate this issue and satisfy the country's development goals within the limits of its available financial resources. If the country suffers from a scarcity of financial assets, then a plan should be made to ration capital and use it according to the development objectives priorities. If capital surplus exists, the planner's major responsibility is to find avenues to absorb it by designing effective investment strategies which will result in sustainable economic growth.

2.10.5 Institutional Structure

Every country has its own institutional setting with varying degrees of complexity. In many developing countries the institutional limitations may

hinder development initiatives and limit the economy's absorptive capacity. A sluggish institutional setting may have causes ranging from cumbersome governmental administrative procedures to the slow evolution of the decision-making process. These obstacles to development can be reduced by designing development strategies that can cope with a rigid institutional environment and achieve the plans stated objectives. Such effectiveness can be achieved by studying each country individually, and dealing with its specific problems.

2.11 The Saudi Arabian Planning Experience:

The history of development planning in Saudi Arabia started when the government invited the International Bank of Reconstruction and Development (IBRD) to send a mission to investigate the possibilities of economic development. The IBRD visited the country in 1960, one of the recommendations was creation of central planning body. In 1961, the central planning council was established and was entrusted with the technical and financial responsibility for planning and implementation of the project. In 1965, the central planning organisation (CPO) was established to replace the central planning council.

The government first serious planning effort was

the production of the first five-year development plan in 1970 to cover the period from 1970 to 1975. The CPO was replaced by the establishment of Ministry of Planning in 1975, also at the same time the second five-year plan was announced. Then the third and fourth five-year development plans followed.

The Saudi government has adopted central planning and all government agencies play a role in both planning and execution of the Kingdom's development plans. The Ministries of Planning and of the Finance and National Economy played a key role, the former in the coordination of development plans and the latter in the provision of statistical information. The structure of the national planning process starts with the submission of planning guidelines to the King. Sectoral planning is subsequently undertaken by the respective agencies in consultation with the Ministry of Planning. Following the sector planning phase, the Ministry of Planning, under the policy direction of the ministerial planning committee, is responsible for plan coordination.

2.11.1 The First Development Plan:

The first development plan, covering the period from 1970 to 1975, was under a financial constraint, because oil revenues, the major source of income, were very low, but the increase in the oil revenue during

the plan period made the government revenue more than expected and eased that financial constraint. The plan objectives were to achieve an average annual growth of the gross domestic product (GDP) of 9.8 percent compared with 8.5 percent growth rate before the plan.⁽¹⁾ The plan concentrated on building the infrastructure needed, and expected the industrial sector to grow by 14 percent annually and the agricultural sector to grow by 4.6 percent annually. The actual growth rate of GNP surpassed the target of 9.8 percent to reach 13.5 percent during the plan as Table 2.1 shows. This high growth rate was affected by the increase in both the production and prices of oil. But the rate of growth in both the agriculture and industrial sector was less than the expected growth rate of 4.6 percent and 14 percent, they only achieved 3.6 percent and 11.6 percent annual growth rate, respectively. However, this plan was the first experience and it achieved a relative success in establishing some needed infrastructure in the country.

2.11.2 The Second Development Plan:

This plan started in 1975 to 1980 during a period of high oil revenues which eliminated any financial

1. Sabbab A., Planning and Development in Saudi Arabia, 1977, p.85.

TABLE 2.1

PROJECTION AND ACTUAL GROWTH RATE
FOR GROSS DOMESTIC PRODUCT
DURING THE FIRST PLAN (1970-1975)

Sector	Projection (Percent)	Actual (Percent)
Total GDP	9.8	13.5
Oil	9.1	14.9
Non-oil (private)	12.0	11.0
Agricultural	4.6	3.6
Manufacturing	14.0	11.6
Construction	10.4	18.6
Transport, Communication and Storage	12.9	17.0
Government	7.0	7.8

Source: A. Sabbab, Planning and Development in Saudi Arabia,
1977, p.85.

constraints. The government allocated substantial sums for building of the infrastructures. The country faced a problem of the growing needs of the skilled and semi-skilled labour force. Also during that period was the problem of the ability of the country to absorb all the surplus funds.

The objectives of the second development plan were determined as follows:

1. Assure the defense and internal security of the Kingdom.
2. Maintenance of a high rate of economic growth by developing economic resources, maximising earnings from oil and conserving deflatable resources.
3. Reduction of economic dependence on exportation of crude oil (by moving downstream into refining, processing natural gas, petrochemical and ancillary industries, in addition to developing other domestic industries such as fertilisers, steel and cement).
4. Develop human resources by education, training, and raising the standards of health.
5. Increase the well-being of all groups within the society.
6. Development of physical infrastructure to support

the achievement of the above goals.⁽¹⁾

The plan objectives were to achieve a growth rate of 13.3 percent annually in real terms of non oil GDP. As Table 2.2 shows, the actual growth rate surpassed the target rate to reach 15.1 percent.

By the end of the second plan period the achievements were as follows:

1. Throughout the period (1975-1980) production of crude oil achieved great growth to reach an average of 8.5 million barrels per day.
2. The government commenced the design and construction of the world's largest gas gathering program for the collection, fractionation and distribution of 34 billion cubic meters of gas per year.
3. The Saudi Basic Industries Corporation was formed in 1976 by the government to develop the hydrocarbon based industry.
4. The Royal Commission was established in 1975 to plan and construct two major industrial complexes in Jubail and Yanbu.
5. Water supplies increased widely through drilling 960 new wells, building 28 dams and providing

(1) Ministry of Planning, Second Development Plan, (1975-1980), p.4

TABLE 2.2

REAL NON-OIL GDP THROUGH THE SECOND
PLAN (1975-1980), ANNUAL
GROWTH RATE

Sector	Planned	Actual
<u>Productive Sector</u>	13.0	16.0
Agriculture		5.4
Mining	4.0	17.1
Manufacturing	15.0	15.4
Utilities	14.0	24.4
Construction	15.0	17.2
<u>Service Sector</u>	13.3	14.1
Trade		22.1
Transportation	15.0	21.1
Finance	9.7	13.0
Other Services	14.0	13.9
TOTAL NON-OIL SECTOR	13.3	15.1

Source: SAMA, Annual Report, 1980

179,000 cubic meters per day of desalinated water⁽¹⁾.

During the first and second development plans, inflation was one of the major problems which threatened the standard of living. At the end of the first plan the inflation rate reached its maximum 42 percent. The problem was due to the low absorptive capacity in view of inadequate infrastructures and limited domestic supply. The high increase in the level of nominal income of the Saudi consumers translated into a high demand for goods and services, while domestic supply was very limited. Even though supplies rose through the mobilization of domestic resources, they could not respond to the soaring demand, and the result was "demand pull" inflation that subsequently led to an upward spiral in wages and inflation. Saudi Arabia was affected by the world inflation because it depends heavily on imported goods, materials, machines, etc. Therefore, substantial portions of the inflation were due to the world inflation, or "imported inflation". This kind of inflation is unavoidable in the short-run, but with the diversification of the industry in the long-run, the country could achieve a higher level of self-sufficiency and mobilise more domestic production.

(1) Ministry of Planning, The Third Development Plan, (1980-1985), pp. 63-70.

By the end of the second development plan the government controlled inflation by reducing government expenditure through the last three years of the second plan. Also by increasing capital formation through the development process which accelerated growth in supply. Finally they controlled inflation by developing the existing ports, expanding capacity and increasing the number of piers, raised the productivity of ports.

2.11.3 The Third Development Plan:

The third development plan was formed under better conditions than the previous two plans. As the second plan, the third development plan also started in a period of high oil income, but the major physical constraints to development, while not completely eliminated, had been reduced and infrastructure was adequate. The country also faced the high influx of foreign labour from abroad.

In order to curb with what was considered a large number of foreign workers coming into the country, a new strategy was established which emphasised high growth in certain sectors which proven potential. The third plan will more efficiently utilize domestic and foreign skilled manpower in capital-intensive hydrocarbon and other manufacturing industries, in agriculture and mining, as strategies

of further diversification of the economy⁽¹⁾. The petrochemical industry is one major area planned through the third plan to diversify the economy.

The main objectives of the third plan was nationalising the development of human resources through education, training and the improvement of health facilities. The strategy aimed at increasing the supply as well as the productivity to reduce the country's dependence on expatriate labour. The third development plan allocated approximately 17 percent of total spending on human resources development compared with 13 percent in the second plan. The annual growth rate in employment is expected to decline from 7.2 percent in the second plan to 1.2 percent in the third plan because of the projected decline in foreign labour to less than 0.5 percent through the third plan.⁽²⁾

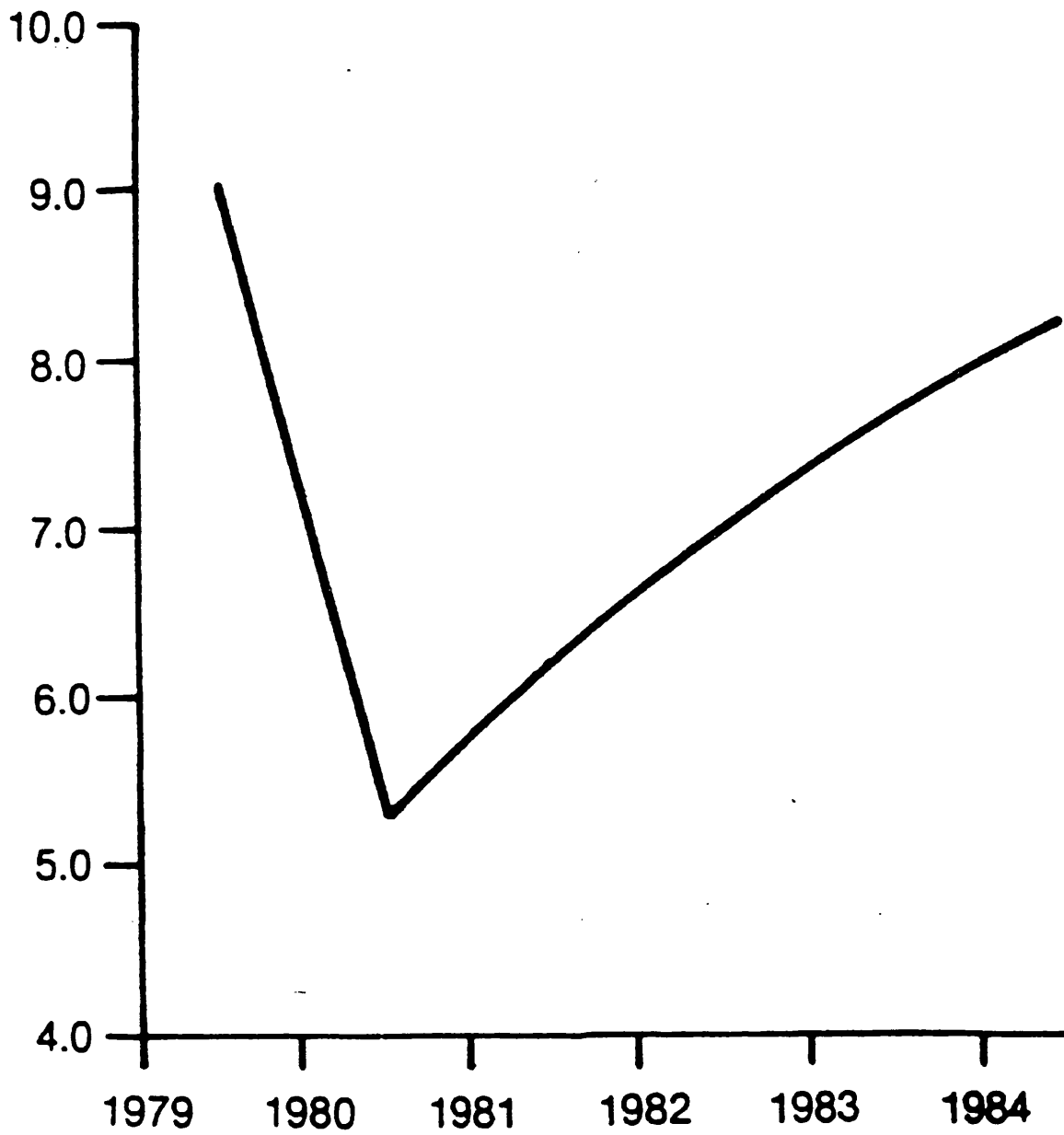
The production of oil is expected to continue at levels which generate enough revenue to cover the financial requirements, as shown in Figure 2.1 and natural gas will be utilised efficiently as energy and feedstock in the petrochemical and other hydrocarbon industries.

(1) El Mallakh R. An Overview of the Third Development Plan of Saudi Arabia, 1982, p.3.

(2) El Mallakh R., An Overview of Third Development Plan of Saudi Arabia, 1982, p.38

FIGURE 2.1

Minimum Level of Oil Exports
Required to Finance Third Development
Plan (1980-1985)



The sectoral growth rates in the non-oil economy began to reflect desired structural changes due to strong growth in manufacturing, agriculture and financial services. The sectoral growth rates were: for agriculture 8.7 percent, manufacturing 14.1 percent and the utilities 24 percent as shown in Table 2.3.

By the end of the Third Plan significant advances were made in the material and institutional conditions affecting individual and social welfare. The basic services in housing, health and education were provided to the majority of the population. Conditions of poverty, deprivation, illiteracy and poor health have been largely eradicated. A large scale modern infrastructure is near completion and agriculture output has expanded.

2.11.4 The Fourth Development Plan:

The fourth development plan covered the period from 1985 to 1990. The basic objectives of the plan were determined as follows:

1. To safeguard Islamic values and defend the Faith.
2. To defend the country and maintain the security and social stability of the Kingdom.
3. To create an environment where the working and productive Saudi citizen can receive appropriate rewards for his endeavours.

TABLE 2.3

REAL NON-OIL GDP THROUGH THE THIRD
PLAN (1980-1985) ANNUAL
GROWTH RATE

Sector	Planned	Actual
Producing Sectors		
Agriculture	5.4	8.7
Mining	9.8	5.7
Manufacturing	18.8	14.1
Utilities	29.5	24.0
Construction	(-2.5)	(-1.4)
Service Sectors		
Trade	8.4	8.8
Transport	12.9 [†]	7.1
Real Estate	7.3 [†]	2.1
Finance	]	13.1
Other Services	3.0	7.9
Government	7.2	5.8
Total Non-Oil Sector	6.2	5.1

* Planned growth for Real Estate and Financial Services combined.

** Less imputed bank services charges.

Source: Ministry of Planning, The Fourth Development Plan (1985-1990), p.15

4. To develop human resources, thus ensuring a constant supply of manpower, and upgrading and improving its efficiency to serve all sectors.
5. To raise educational standards to keep pace with the development requirements of the country.
6. To reduce dependence on the production and export of crude oil as the only source of income.
7. To continue with real structural changes in the country's economy through continual transformation to produce a diversified economic base.
8. To develop mineral resources and to encourage their discovery and utilisation.
9. To concentrate on qualitative development by improving and developing the performance of the utilities and facilities already established during the three development plan periods.
10. To complete the infrastructural projects necessary for overall development.
11. To achieve economic and social integration between the GCC countries.⁽¹⁾

In the fourth plan period the economy continue to undergo structural change. The structural changes are the decline of sectors which are primarily dependent

(1) Ministry of Planning The Fourth Development Plan (1985-1990) p.41

on budget expenditures such as construction, distributive trade, transport and communications. The producing sectors such as manufacturing and agriculture, and financial and business services sector, will contribute to the economy's diversification. In the fourth plan expenditure program a substantial financial support built to encourage the private sector to take the initiative and mobilise its own resources.

The long-run objective has always been the diversification of the economy. The ultimate objective of reducing dependence on oil translates into the present task of creating a new structural basis for stable future growth. Nevertheless, it would be misleading to expect that the multiple advantages which crude oil secures for the Saudi can, in the foreseeable future, be substituted by another hitherto untapped natural resource. Therefore, the development strategy has taken the realistic course. Instead of turning from crude oil, the objectives have been to maximise the advantages of being the most efficient (in cost terms) and the most reliable (in terms of quantities of hydrocarbon reserves) among the leading oil producers in the world.

Saudi Arabia has 25 percent of the world's proven oil reserves and vast quantities of associated and

non-associated gas. These natural resources make Saudi Arabia a natural location for the production of petrochemicals. The combination of abundant resources and low costs secures a long-run comparative advantage over other competitors⁽¹⁾.

The petrochemical industry was never intended to be a complete substitute for oil as a foreign exchange earner. Even though the demand for petrochemical products is bound to increase, the Saudi's share will only represent a fraction of total world supply.

The Five year Plan, 1990-95 - Proposed expenditure in million riyals - is 753,000 as shown below.

FIVE-YEAR PLAN, 1990-95
(proposed expenditure in million riyals)

Defence	255,000
Education	140,959
Health and social services	87,098
Transport and communications	52,600
Water, energy and mining	24,513
Royal Commission for Jubail and Yanbu	5,998
Industry and construction	11,525
Electricity	13,515
Agriculture	14,411
Public works and environment	45,285
Other.	102,096
Total.	753,000

Source: The Middle East and North Africa 1991

(1) Ministry of Planning The Fourth Development Plan (1985-1990) p.44

CHAPTER 3

THE ROLE OF OIL AND GAS IN THE DEVELOPMENT PLAN OF SAUDI ARABIA

3.1 INTRODUCTION

The dominance of oil in the Saudi Arabian economy is well known. Saudi Arabia is the main oil producer in the Gulf region and has the largest reserve pool. The Saudi production of 9.9 billion barrels per day in 1980, accounted for over 70 percent of total GCC (Gulf Co-operation Council) production, and the reserves in Saudi Arabia were 62 percent of the estimated total.

The large amount of crude oil exported from Saudi Arabia is the result of a number of factors:

1. The low cost of production, and transporting crude oil. Most oil wells are large, close to the surface, close to costal outlets. The average productivity of oil wells is estimated to be over 400 times the world average. Another advantage has been the falling unit costs of transporting oil across the oceans as larger supertankers have been brought into use. This is important with respect to the US market, where Saudi oil can be delivered at prices below the domestic production costs.
2. The crude oil producers can reduce or increase

supply without any major consequences for the economy. They could open or close the oil tap at the government discretion since the production of crude oil has often been below shut-in capacity and above the foreign exchange requirements.

However, oil supplies are finite and non-renewable oil in Saudi Arabia will run out in the lifetime of its grandchildren. So in the early 1970s, the government decided to diversify the economy by going downstream and making better use of their other abundant resources.

Saudi Arabia has a few resource endowments other than oil and gas which play a vital role as a financial source and as a source of energy, including the use of natural gas as a recovery medium in oil production, and as a raw material for development projects.

The level of oil production in Saudi Arabia is heavily influenced by the world oil market and OPEC policies. The Saudi share of world oil production has fallen from 16.6 percent in 1980 to 7.4 percent in 1984 and OPEC share of the world production has fallen from 45 percent to 31 percent over the same period as shown in Table 3.1.

TABLE 3.1

WORLD OIL PRODUCTION

	1975		1980		1984	
	mbd	%	mbd	%	mbd	%
Saudi Arabia	7.1	13.3	9.9	16.6	4.3	7.4
OPEC	20.1	37.6	17.0	28.4	13.5	23.4
(Excluding Saudi Arabia)						
Non-OPEC	26.2	49.1	32.8	55.0	40.0	69.2
TOTAL WORLD	53.4	100.0	59.7	100.0	57.8	100.0

SOURCE: Saudi Arabia Ministry of Planning Fourth Development Plan 1985-1990, p.149.

The reasons for this decline are the increasing capacity of non-OPEC producers, particularly the North Sea countries, Mexico, Canada and Egypt as shown in Table 3.2; and also the decrease in the world demand for oil resulting from world economic recession, the development of alternative energy sources and substantial conservation measures.

3.2 Oil as a Source of Income

Oil is the main source of foreign exchange for Saudi Arabia. In 1983, for example, oil exports comprised approximately 100 percent of the total exports from Saudi Arabia⁽¹⁾

Realizing that oil is a finite and exhaustible resource and that depending entirely on crude exports will make their economies vulnerable to many international events such as market instability, OPEC member countries wish to reduce this dependence by better exploiting their indigenous resources, primarily the vast quantities of natural gas, through downstream processing. These countries plan to use oil revenues to finance these ventures.⁽²⁾

OPEC member countries domestic consumption of

(1) OPEC Statistical Bulletin, 1983

(2) This was the subject of the OPEC Seminar on "Downstream Operation in OPEC Member Countries: Prospect Problems", held in Vienna, October 9-11, 1978.

Table 3.2

CRUDE OIL PRODUCTION IN THE OPEC COUNTRIES AND THE REST OF THE WORLD (million barrels per day)

	1986	1987	1988	1989
Middle East OPEC:				
Saudi Arabia	5.150	4.360	5.255	5.260
Kuwait	1.250	1.075	1.340	1.600
Neutral Zone ¹	0.345	0.390	0.320	0.400
Iran	1.905	2.310	2.265	2.865
Iraq	1.745	2.090	2.600	2.825
UAE—Abu Dhabi	1.090	1.200	1.280	1.600
UAE—Dubai	0.390	0.420	0.400	0.400
Qatar	0.355	0.340	0.355	0.395
North Africa OPEC:				
Libya	1.045	1.000	1.055	1.145
Algeria	1.125	1.135	1.090	1.170
Other OPEC:				
Venezuela	1.845	1.775	1.920	1.980
Nigeria	1.465	1.290	1.365	1.605
Indonesia	1.400	1.320	1.325	1.395
Ecuador	0.280	0.180	0.305	0.285
Gabon	0.160	0.155	0.175	0.220
Other Middle East and North Africa:				
Oman	0.560	0.580	0.595	0.390
Bahrain	0.050	0.042	0.045	0.043
Syria	0.190	0.232	0.274	0.340
Egypt	0.835	0.915	0.880	0.890
Tunisia	0.110	0.104	0.102	0.100
Turkey	0.040	0.051	0.050	0.061

Table 3.2 (continued)

	1986	1987	1988	1989
Other producers:				
USA	10.230	9.945	9.765	9.175
Canada	1.840	1.815	1.800	1.725
Mexico	2.750	2.875	2.855	2.875
Trinidad and Tobago	0.165	0.165	0.150	0.160
Colombia	0.300	0.385	0.380	0.400
Argentina	0.430	0.430	0.450	0.450
Brazil	0.595	0.620	0.695	0.640
Brunei	0.165	0.140	0.145	0.145
India	0.625	0.615	0.645	0.690
Malaysia	0.540	0.505	0.545	0.575
Australasia	0.610	0.620	0.600	0.575
United Kingdom	2.045	2.335	2.365	1.905
Norway	0.910	1.005	1.155	1.530
USSR	12.560	12.775	12.760	12.475
China, Peoples Republic	2.630	2.675	2.750	2.790
Other Eastern Europe	0.455	0.430	0.423	0.410
World total	60.375	60.150	62.350	63.560
World total*	44.710	44.250	46.405	47.885
OPEC total	19.635	19.115	21.145	23.215
OPEC % World total*	43.9	43.2	45.6	48.5
Middle East and North Africa total	16.216	16.330	18.127	19.895
Middle East and North Africa % World total*	36.3	36.9	39.1	41.5

* Includes shale oil, oil sands and natural gas liquids.

* Shared equally between Saudi Arabia and Kuwait.

* World total less the USSR, the People's Republic of China and Eastern Europe.

Source: The Middle East and North Africa 1991

their crude oil production is small; however, consumption is increasing as a result of expanding refinery capacities as part of industrial development. The utilization of natural gas in OPEC countries also increased sharply. Approximately 67 percent of the natural gas produced was flared in 1974; in 1978 this percentage decreased to fifty five percent⁽¹⁾.

Because oil exports of the Third World oil-producing nations are the main source of their foreign exchange earnings, the value of exports and thus their financial capital grew dramatically with the large increase in the value of these countries exports shown in Table 3.3. The accumulation of surplus funds brought the issue of absorption capacity to their development plans. Aiming to open avenues for improving the absorptive capacity of the economy, Saudi Arabia's second development plan, for example, covered almost all sectors of the economy from industry and agriculture to human resources and social development⁽²⁾.

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1. Mustafa Burham, Arabian Petrochemical Industry, A paper presented to the Organisation of the Arab Petroleum Exporting Countries, Seminar on Hydrocarbon Industries, Kuwait, 1980 (in Arabic).
 2. Ragaei El Mallakh (1982) Saudi Arabia: Rush to Development (London: Croom Helm) p.163

TABLE 3.3

OPEC Countries Values of Exports FOB, 1968-1989 (Million US dollars)

COUNTRY	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
Algeria	830	934	1009	857	1306	1896	4688	4706	5259	5945	6328
Ecuador	226	193	190	199	326	532	1124	974	1258	1436	1558
Gabon	125	143	144	178	228	329	766	943	1138	1343	1109
Indonesia	731	854	1108	1234	1777	3211	7426	7102	8547	10583	11643
Iran	1881	2100	2623	3825	4038	6191	21575	20215	25321	24260	22101
Iraq	820	823	847	1138	1108	1944	6601	8297	9272	9649	11061
Kuwait	1285	1372	1693	2271	2558	3815	10967	9184	9832	9751	10415
Libya	1871	2167	2366	2711	2945	3996	8263	6840	9562	11421	10202
Nigeria	582	897	1240	1830	2178	3524	9707	7785	10089	11781	10560
Qatar	211	223	237	314	397	618	2015	1809	2209	2012	2320
Saudi Arabia	1780	1871	2353	3477	4560	7818	31248	27998	36431	41222	37857
United Arab Emirates	342	428	510	835	1082	1803	6392	6970	8691	9685	9154
Venezuela	2511	2496	2627	3125	3162	4896	11070	8799	9301	9551	9188
TOTAL OPEC	13195	14501	16947	21995	25664	40572	121842	111621	135109	148910	143500

TABLE 3.3 (continued)

COUNTRY	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Algeria	9552	13875	14408	13189	12117	12795	12841	7429	8606	7679	.....
Ecuador	2104	2481	2542	2140	2223	2583	2905	2172	1928	2192	2354
Gabon	1849	2176	2213	2173	1953	2011	1951	1271	1288	.....	.....
Indonesia	15590	23950	25164	22328	21146	21903	18590	16075	17135	19465	22160
Iran	19975	14084	12537	16537	19499	13220	13328	8322	.....	.....	.....
Iraq	21432	26279	10530	10241	9785	10938	12224	9007	9014	.....	.....
Kuwait	18422	19685	16115	9867	10949	18881	10487	7383	8264	7661	11476
Libya	16085	21919	15576	13948	11084	11136	10929	7720	8052	.....	.....
Nigeria	17713	25787	19374	16555	11648	14525	12548	5175	7365	.....	.....
Qatar	3733	5672	5691	4252	3384	4513	4203	2720	.....	.....	.....
Saudi Arabia	57514	102261	113418	76248	47815	46842	27481	20185	22590	23738	27741
United Arab Emirates	13578	20740	20240	16837	13950	14104	14043	15837	.....	.....	.....
Venezuela	14317	19221	20125	16499	15002	13417	14438	8660	10577	10113	12983
TOTAL	211863	299129	277933	220810	180436	179868	155968	111956			

Source: International Monetary Fund (IMF), International Financial Statistics, March 1991.

3.3 Major Sources of Energy

Oil and gas are considered major sources of high thermal energy, which makes them a Key Factor in energy-intensive industries, as well as in power generation, water desalination, and as a feedstock for the petrochemical industry. Oil is more expensive than natural gas, although transportation and storage of oil are easier and less expensive than for natural gas. The oil-producing countries have a vast quantity of gas. A large portion of it is flared as mentioned earlier, but the industrial development plans of Saudi Arabia is now concentrating heavily on reducing this wastage. The development plans also involve further processing of oil by expanding their refining capacity to meet their own growing needs for refined products and to increase their export shares.

3.4 Energy - Intensive Industries

The types of industries advantageous to OPEC member countries are those which consume a sizeable quantity of natural gas which would otherwise be wasted. Several energy-intensive industrial projects have been initiated in these countries, including steel, aluminum and cement.

3.4.1 Steel

Coal has been the primary source of energy in the steel industry for several decades, but new methods

developed in this field, have led to the use of natural gas as an energy source in this industry, especially in the production of sponge iron.⁽¹⁾ The direct reduction (DR) method is an improvement in steel production that is ideally suited for LDCs. It uses small-scale technology, is easy to operate and does not create environmental problems.⁽²⁾ This development in the steel industry and the rise in steel consumption in some OPEC countries (for example, per capita steel consumption rose from 32kg in 1970 to 65kg in 1974 and was expected to reach 100kg in 1985)⁽³⁾ encourage those countries to make large investments in the steel industry, employing the DR technique. Table 3.4 shows the steel projects and steel production capacities in some OPEC and Middle Eastern Countries.

3.4.2 Aluminum

Like steel, aluminum is an energy-intensive industry. However, production processes may differ. Aluminum usually requires high electrical energy for reduction operations, the major component of

(1) BURHAM, Mustafa (1983), "The Best Utilization of Natural Gas in Arab Countries" in The Arab Oil Industry (Kuwait: OPEC) P.234 (in Arabic)

(2) EL-ZAIM, Issam (March 1982) "Energy and Industry with Special Reference to the Arab Countries" proceeding of the Second Arab Energy Conference (Doha, Qatar), p.440

(3) Ibid

TABLE 3.4

Steel and Aluminum Projects Based on Natural Gas
in the Middle East

(1980-1981; capacity in 1000 metric tons/year)

Country	Location	Steel	Aluminum
Saudi Arabia	Jubail	3,500	210
Qatar	Um Said	400	---
United Arab Emirates	Jabil Ali	--	135
Iraq	Khor Alzbair	1,485	150
Libya		--	110
Algeria	Maselu	--	140
Bahrain		--	170

Sources: Ragaei El-Mallakh, Saudi Arabia: Rush to Development (London: Croom Helm, 1982) p. 132; Mustafa Burham, Best Utilization of Arabian Natural Gas (Kuwait: Arab Oil Industry, Organisation of the Arab Petroleum Exporting Countries, 1983), p.235.

the production process.⁽¹⁾ This energy can be generated by using low-cost natural gas, which makes aluminum production in OPEC countries more competitive within the international market. Other producers must bear the high costs of buying the energy required for production. Nearly all countries with aluminum smelters (see Table 3.4) import the ore from abroad. Therefore, the industry is affected by transportation costs and the uncertainty of having to depend on other countries to supply raw materials.

3.4.3 Cement

The cement industry began before most other development projects in the oil-producing countries. However, as development programs were initiated, the demand for cement increased. In Saudi Arabia during its three Five-year development plans (1970-1985), cement production grew at an annual rate of 17.5 percent, because of high domestic demand.⁽²⁾ The investment in the cement industry varies from one country to another, from 5 percent of total investment in industrial projects in Saudi Arabia to 13.4 percent of such projects in Iraq.⁽³⁾ This expansion in the cement industry resulted from the expansion of the physical infrastructure required to support

(1) Burham, p.234

(2) "Kingdom of Saudi Arabia, Ministry of Planning, Achievement of The Development Plans (1970-1983), p.58

(3) EL-ZAIM, Issam, p.469

development plans.

3.5 Water Desalination and Power Generation

The abundance of hydrocarbon resources plays an important role in alleviating the problem of water scarcity in some OPEC countries. The Gulf States, for example, are an arid region with no rivers or lakes and limited underground aquifers. The aquifers cannot be recharged due to extremely limited rainfall. These countries rely on the desalination process to alleviate their water shortage.

The history of desalination goes back to the early 1950s. Industrial development and population growth in the Gulf states have been high. The population growth in Saudi Arabia is at a rate of 2.8 to 3 percent per year.⁽¹⁾

The other factor increasing the demand for water is expansion of agriculture as a part of these countries' development programs.

Power generation relies on oil and gas. Most OPEC countries do not own any other sources of energy, such as coal or hydropower. Electricity and desalinated water are produced in dual-purpose plants in all Gulf states. In these plants the electricity

(1) EL-MALLAK, p.22

is generated by gas turbines and the exhaust gases at a temperature around 540°C are used as a heat source for seawater distillation, using a process called multi-stage flash evaporation.⁽¹⁾ The demand for both electrical energy and potable water has risen as the result of development programs in most Gulf states, as well as in other oil-producing countries. Saudi Arabia's third Five-year development plan allocated approximately \$1.6 billion for power generation projects and about \$1.2 billion for water desalination.⁽²⁾ However, not all oil producing countries use their oil and gas resources in this manner. Iraq, Iran, and Nigeria have abundant water resources in rivers, lakes and underground aquifers. Nevertheless, some of these countries derive the thermal energy required for power generation from oil and natural gas.

3.6 Utilisation and Further Processing of Oil and Gas:

The increase in the national incomes of Saudi Arabia and other OPEC countries as oil prices increased, still left their economies outside the oilfields underdeveloped. The standard of living increased, but essentially and primary through capital consumption, which is the depletion of oil reserves.

(1) Diamond, Michael, p.629

(2) El-Mallakh, p.407

Saudi Arabia as well as some other oil-producing countries are increasingly aware of the fact that any major devaluation of their oil would bring financial difficulties, and their oil is a finite resource. Alternative sources of income must be found; in the same time, ways and means must be examined to upgrade the revenues from the decreasing supplies of oil and gas.

The planners of oil-producing countries adopted the strategies of full utilization of their indigenous hydrocarbon resources served different purposes. In addition to their use for producing energy, these countries followed various development strategies of using the resources as Feedstock for refining and petrochemical industries. Saudi Arabia is the leading OPEC member in this regard, investing about \$50 billion to establish two petrochemical centers in Jubayl and Yanbu on the east and west coasts of the country.⁽¹⁾ Nigeria allocated \$11.4 billion for petrochemical, fertilizer, and refining projects in its Fourth development plan (1982-1985)⁽²⁾. Other OPEC members are no exception, and such downstream projects have spread to almost all of them.

(1) Crane, R. D. (1978) Planning the Future of Saudi Arabia: A Model for Achieving National Priorities, (New York: Parger), p.14.

(2) Nigerian National Oil Corporation (1982) Progress of Public Sector Participation in Nigerian Oil Industry, (Lagos), p.8.

3.6.1 Petroleum Refining

Crude oil by itself does not have any direct use. Its full value can be seen after it is processed into refined products for specific end uses. Refining is a first step necessary for downstream development of fuel and non-fuel uses. Crude oil is converted into many different fuels for energy uses as well as into lubricants, waxes, gasoil and naphtha which are basically feedstocks for the petrochemical industry.

Refining operations are almost as old as the discovery of oil. Its history goes back to 1861, when the first refinery was built near Titusville, Pennsylvania, in the United States.⁽¹⁾ However, with the discovery of oil in several parts of the world, refineries have spread as well. This industry grew with the demand for refined products as a result of the development of modern means of transportation and other fuel consumption engines.

Prior to World War II, about 70 percent of crude oil was refined in the producing countries. However, after the war and in the early 1950s refining activities shifted to the industrialized nations as a

(1) Organisation of the Petroleum Exporting Countries Energy Studies Department. Seminar on "Downstream Operation in the OPEC Member Countries: Prospects and Problems" Vienna: October 1978), p.1

result of economic expansion in those countries.⁽¹⁾

The post-war era witnessed the emergence of large refining centers in the industrialized world, such as the Rotterdam Refining Complex in the Netherlands. During the 1950s, the OPEC countries' refining capacities were designed to meet domestic demand and, in a few cases, to handle regional exports, as in the Gulf area⁽²⁾.

When the industrialization development plans were launched in the early 1970s, expansion of refining capacity was one of the objectives; however, refining capacity varies from one country to another. Saudi Arabia is boosting its refining capacity to reach about two million barrels per day.⁽³⁾ The Saudi Arabia oil refinery capacity is shown in Table 3.5. OPEC studies estimate domestic consumption of refined products in Saudi Arabia will reach about 600,000 barrels per day by 1990,⁽⁴⁾ leaving the country approximately 1.4 million barrels per day for export. In Nigeria the case is different. With modest

(1) Luis Vallenilla, Oil: (1975) The Making of New Economic Order Venezuelan Oil and OPEC (New York: McGraw-Hill), p.80.

(2) British Petroleum, (1977) Our Industry Petroleum 5th Edition (London British Petroleum) p.246

(3) Gorst, Isabal "Entering the Downstream Market", The Petroleum Economist, November 1984, p.407.

(4) OPEC Secretariat, Energy Studies Department, (December 1984) Report on the Impact of Member Countries Product Export on Crude Oil Prices (Vienna) p.134

TABLE 3.5

OIL REFINERY CAPACITY
(Thousand Barrels per Calendar Day)

	<u>Actual Capacity</u> <u>1979</u>	<u>1984</u>	<u>Third Plan</u> <u>Target</u>	<u>Under Con-</u> <u>struction</u>
<u>Domestic Refineries</u>				
Jeddah	85	85	85	-
Riyadh	20	135	135	-
Yanbu (Phase I)	-	154	154	-
Yanbu (Phase II)	-	-	250	-
Domestic Capacity	105	374	624	-
<u>Export Refineries</u>				
Jubail	-	-	250	250
Yanbu	-	-	250	250
Rabigh	-	-	303	303
Ras Tanura	450	450	450	-
Arabian Oil	30	30	30	-
Getty Oil	50	50	50	-
Export Capacity	530	530	1,333	803
TOTAL CAPACITY	635	904	1,957	803

SOURCE: Saudi Arabia Ministry of Planning Fourth Development Plan
1985-1990, p.151

expansions, refining capacity has increased from 46,000 barrels per day in 1975 to 247,000 barrels per day in 1983, leaving the country with a shortage of refined products. However OPEC predicts that this country will be self-sufficient in 1990.⁽¹⁾ Venezuela's case differs from both Saudi Arabia and Nigeria - Venezuela has been oriented toward refined product exports since the 1950s, even though expansion took place at an annual rate of 8 to 15 percent.⁽²⁾ During the 1970s Venezuela did not experience any significant expansion. In 1983, however, the country's refining capacity rose about 1.3 million barrels per day. The same rate of expansion is expected to prevail through 1990.⁽³⁾ The Table 3.6 shows the OPEC refining production through 1990. In the future, some OPEC countries may experience a significantly large surplus refining capacities. How they might react to this situation will be discussed in the next chapter.

3.6.2 Petrochemicals

The petrochemicals industry began in the late nineteenth century when it utilized the gas produced by the coal-burning process. The industry flourished in countries with abundant coal resources, such as England, the United States, France and Germany.

(1) Ibid, p.106

(2) Vallenilla, p.81

(3) OPEC Secretariat, Report on Impact of Member Countries

TABLE 3.6

Production of Refined Products in OPEC Countries
(1975-1982) and Outlook for the Refining Industry
(1983-1990; 1,000 b/d)

Country	Actual							Projected		
	1975	1976	1977	1978	1979	1980	1981	1982	1983	1985 1990
Algeria	113.2	100.4	88.5	1141.1	153.0	217.4	283.7	471.2	471	471 561
Ecuador	39.8	42.0	39.4	79.6	83.3	90.3	86.7	94.5	95	95 214
Gabon	17.0	27.2	34.2	33.0	35.0	21.4	22.7	44.0	44	44 44
Indonesia	304.1	306.0	421.3	436.9	509.7	526.9	530.8	498.0	498	898 898
Iran	644.2	651.9	724.9	670.0	661.0	582.0	629.6	670.0	670	690 1290
Iraq	135.5	154.7	166.4	182.6	183.0	187.0	190.0	215.0	365	596 596
Kuwait	337.4	410.8	407.2	410.2	539.4	434.2	336.9	594.0	614	614 770
Libya	37.6	51.0	94.2	114.2	119.0	108.6	89.7	130.0	130	300 600
Nigeria	46.7	55.5	48.2	60.2	89.0	90.5	158.7	247.0	272	415 n.a
Qatar	3.7	5.4	6.5	6.2	9.4	7.7	7.8	13.0	63	63 63
Saudi Arabia	577.6	703.4	731.4	776.9	834.9	826.5	834.9	878.0	1048	1548 2033
United Arab Emirates	--	6.1	11.0	10.8	13.2	11.7	54.0	135.0	195	180 465
Venezuela	869.5	896.0	975.8	991.4	1009.7	938.0	875.6	1329.0	1329	1329 1329

Source: Compiled from OPEC Annual Statistics Bulletin, 1983 and the Impacts of OPEC member countries product Report

However as refining technology advanced in the 1920's, natural gases replaced coal gases as a Feedstock. The postwar era witnessed substantial development in the petrochemical industry due to the varieties of finished products that could be derived from it (e.g. plastic, clothing, and even protein). OPEC countries initiated modest petrochemical activities in the late 1960's; the Saudi Fertilizer company, for example, was established in 1965. The 1970's saw the establishment of the petrochemical industry on a large scale in OPEC countries, Saudi Arabia led the OPEC group in investment, allocating approximately \$12.5 billion for their petrochemical projects.⁽¹⁾ Table 3.7 shows the petrochemical production capacities of OPEC member countries. As in the refining industry, the immediate task facing these countries is to find consumers for their products, to turn these investments into successful ventures, and to meet the objective of better utilization of these countries natural resources.

3.7 Oil Resources

Pressure differences drive oil from the reservoir through the well to the surface. The flow of oil depends, among other things, on the pressure of the reservoir. This pressure drops over time, slowing the flow of the oil. Reservoir pressure is maintained

(1) El-Mallakh, p.132

TABLE 3.7

Production Capacity Of Major Petrochemical Products in OPEC
Member Countries (1977-1985; thousands tons/year)

Country	Ethylene	High Density Polyethylene	Low Density Polyethylene	Methanol	Ammonia	Urea	Ethylene Dichloride
Algeria	120	100	150	100	1,980	260	--
Ecuador	--	50	50	--	--	--	--
Indonesia	275	--	--	--	--	--	--
Iran	300	60	100	--	--	--	--
Iraq	170	30	60	1,500	1,600	--	104
Kuwait	--	--	--	660	800	--	--
Libya	350	--	--	330	1,650	2,300	--
Nigeria	300	70	110	--	--	--	69
Qatar	280	--	120	--	660	660	--
Saudi Arabia	2,060	90	770	1,250	720	900	--
United Arab Emirates	--	--	--	--	330	500	--
Venezuela	165	60	50	--	--	--	91

Source: Arab Oil Industry, collection of papers published by the Organization of the Arab Petroleum Exporting Countries (Kuwait, 1983); Proceedings of the Second Arab Energy Conference (Doha, Qatar, 6-11 March 1982), Vol. 4, p.471; Seminar on "Downstream Operation in OPEC Member Countries Prospects and Problems" (Vienna, October 1978; Publication by Organization of Petroleum Exporting Countries; and Isabel Gorst" Saudi Arabia Entering Downstream Market. Petroleum Economist November 1984).

through secondary recovery methods which involve reservoir water flooding and gas or steam injection. Water flooding is used widely in the OPEC countries. Although fresh water is scarce in Saudi Arabia and seawater can create corrosion problems in the oil wells, fresh water injection is a common practice. In 1980 about 2.4 million cubic metres of water per day were injected into the Saudi Arabian oil reservoir. In comparison, only 545,000 cubic metres of water per day were consumed by the country's urban centres.⁽¹⁾ Other arid Gulf countries also use water injection. The adoption of gas injection, or gas drive, will enable at least part of such water to be diverted to other uses, such as expansion of the agricultural sector. The gas injected into oil reservoirs could be recovered as associated gas. Eden et al. estimate that gas injection could recover 15 to 20 percent more oil. With an average primary recovery of 25 to 30 percent, gas injection would increase output by 50 percent.⁽²⁾ Some studies estimate that to recover 0.6 barrels of oil, approximately 1,000 cubic feet of natural gas must be injected into the reservoir.⁽³⁾

(1) Ibid, p.87.

(2) Richard Eden et al., (1982) Energy Economics: Growth, Resources and Policies (London: Cambridge University Press) p.83

(3) Burham, p.240

CHAPTER 4

THE USE OF NATURAL RESOURCES AS A DEVELOPMENT STRATEGY

4.1 INTRODUCTION

Hydrocarbons are the major, if not the only, economic resource of Saudi Arabia. Before the discovery of oil, Saudi Arabia was poor, and the people's standard of living was low. The discovery of oil and the associated foreign exchange earnings helped to alleviate the economic problems from which the country suffered. For a few decades after the discovery of oil, the Third World oil producing countries primarily exported crude oil while burning off the associated natural gas that was produced. However, the realization that oil is a depletable, finite resource, led the producers to optimize their utility from hydrocarbons by initiating and launching ambitious development programmes. Such industrial development commonly became the main objective of the development plans in Saudi Arabia.

In the first Five-Year Development Plan (1970-1975), Saudi Arabia stated this objective: namely, to "diversify the economy and reduce the country's dependence on oil by increasing the contribution of the other productive sectors to the national

product."⁽¹⁾ The OPEC Secretary General summarized the main objectives of investment in downstream industrial projects as being:-

1. to recuperate value added by optimal utilization of hydrocarbon resources:
2. to create employment:
3. to acquire technology:
4. to substitute for imports:
5. to encourage regional development: and,
6. to create a measure of self reliance.⁽²⁾

OPEC members have common economic characteristics; they lack technological expertise, a reliable infrastructure for sustainable growth,⁽³⁾

Many issues must be dealt with when implementing industrial development programmes. Among the OPEC group are vast divergences with regard to the availability of natural resources, economic, political and social structure. They vary in their history and

(1) Kingdom of Saudi Arabia, (1970), Central Planning Organization Development Plan, p.23.

(2) Ali M. Jaidah, (1978), Downstream Operations and Development of OPEC Member Countries, proceedings of the OPEC Seminar on Downstream, (October), p.15.

(3) Ibid, p.13,

experience in the oil industry, the size of the populations, availability of the market, agricultural bases, distance to major consuming markets, balance of payment positions, and command over capital. In this chapter the major issues related to the use of oil and gas as a development strategy will be investigated.

4.2 Natural Gas Resources

The underground oil reservoirs contain dissolved natural gases. This is a result of pressure and heat, and when oil flows to the surface the natural gases are freed. In most of the GCC member countries a certain volume of gases, about 500 cubic feet of associated gases with each barrel of oil. The crude oil production is received at separator and cooling unit, where the heavier fractions are separated in order to avoid losing these gases. The remaining lighter gases come out as gas mix, some of it is reinjected into oil fields for the production of more oil, the other part is used locally or flared into the atmosphere. However, with the increase in oil prices following 1973, the associated gas that is flared declined sharply. In 1971 the proportion of waste for GCC region as a whole (Oman and Bahrain excepted) was 75.6 percent of the region's gross gas production, by 1980, the waste proportion had fallen to 56.4 percent in the whole region, as shown in Table 4.1.

TABLE 4.1

PRODUCTION AND UTILISATION OF NATURAL GAS IN THE GCC REGION:
SELECTED YEARS (MILLIONS OF CUBIC METERS PER YEAR)

		1971			1975			1980		
		%			%			%		
		PRODUCTION	FLARED	WASTE	PRODUCTION	FLARED	WASTE	PRODUCTION	FLARED	WASTE
Kuwait	18,228	11,979	65.7	11,208	4,310	38.5	8,780	1,416	16.1	
Qatar	4,515	3,509	77.7	4,730	3,524	68.8	6,400	1,190	18.6	
Saudi Arabia	25,481	19,896	78.1	47,230	37,412	79.2	53,265	38,368	72.0	
UAE (Abu Dhabi)	10,430	9,385	90.0	14,309	12,938	90.4	14,859	7,608	51.2	
Bahrain	506	n.a	n.a	3,043	n.a	n.a	3,715	509	13.7	
GCC	59,159	44,769	75.6	80,520	58,184	72.3	87,019	49,091	56.4	

SOURCE: Atif A. Kubursi Oil, "Industrialisation and Development in the Arab Gulf States", p.56.

The GCC production of natural gas increased from 59,159 million cubic metres in 1971 to 87,019 in 1980. Saudi Arabia's production had more than doubled by 1980, as shown in Table 4.2.

Another type of natural gas is produced from reservoirs when the extremely high temperatures and pressures might have converted entire oil reservoirs into gas. These isolated stores of gas are called non-associated natural gas or "dry gas". Some analysts have put the figure as high as 25 percent of the world total reserves of non-associated natural gas are located in the GCC region⁽¹⁾.

4.3 Oil as a Vital Resource

Oil is a vital resource that has helped to change the economic status of OPEC member countries since its discovery during the first half of this century. OPEC countries produce approximately 68.9 percent of the world's requirement for crude oil, and they have approximately 471 billion barrels, or 70 percent of the world's proven reserves.⁽²⁾

However, this reserve varies among the 13 member countries. From Saudi Arabia's 35.9 per cent of the total to Gabon's 0.1 per cent.⁽³⁾ Table 4.3 shows the

(1) Atif A. Kubursi, Oil, Industrialisation and Development in the Arab Gulf States, 1984, p.44.

(2) OPEC Annual Statistical Bulletin, 1983.

(3) OPEC Annual Report, 1983, p.64.

TABLE 4.2

GCC GROSS PRODUCTION OF NATURAL GAS
1971 - 1980 (MILLIONS OF CUBIC METERS PER YEAR)

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
Kuwait	18,228	18,344	16,454	13,222	10,827	11,208	10,272	11,124	13,035	8,780
Qater	4,514	5,097	6,213	5,151	5,437	4,730	4,290	4,650	6,677	6,400
Saudi Arabia	25,481	32,568	32,292	47,310	37,812	47,230	48,700	43,748	50,561	53,265
UAE	10,430	11,215	13,690	13,054	12,233	14,309	15,341	13,533	13,700	14,859
Oman	n.a	n.a	n.a	n.a	n.a	n.a	n.a	n.a	n.a	n.a
Bahrain	506	1,132	1,602	1,975	2,876	3,043	3,432	3,715	3,715	3,715
GCC	59,159	68,356	71,251	80,712	69,185	80,520	82,035	76,790	87,688	87,019
OPEC	197,221	213,633	251,964	250,794	222,217	253,706	268,611	268,327	302,618	270,412
World	1,179,000	1,239,000	1,309,000	1,346,000	1,349,000	1,380,000	1,436,000	1,477,000	1,565,000	1,565,000
OPEC/World (%)	16.7	17.2	19.2	18.6	16.5	18.4	18.7	18.2	19.3	17.2
GCC/OPEC (%)	30.0	32.0	28.2	32.2	31.1	31.7	30.5	28.6	28.9	32.2
GCC/World (%)	5.0	5.5	5.4	6.0	5.1	5.8	5.7	5.2	5.6	5.6

SOURCE: Atif A. Kubursi, "Oil, Industrialisation and Development in the Arab Gulf States", p.57

Table 4.3

PROVEN CRUDE OIL RESERVES IN THE WORLD AS AT 1 JANUARY 1990 (billion barrels)

	Years of production* at 1989 levels		Years of production* at 1989 levels	
	Reserves		Reserves	
Middle East and North Africa				
Saudi Arabia	255.0			
Kuwait	94.5			
Neutral Zone	5.2			
Iran	92.9			
Iraq	100.0			
UAE—Abu Dhabi	92.2			
UAE—Dubai	4.0			
UAE—Sharjah	1.9			
Qatar	4.5			
Oman	4.3			
Bahrain	0.1			
Syria	1.7			
Algeria	9.2			
Libya	22.8			
Egypt	4.5			
Tunisia	1.8			
Middle East and North Africa total	694.6			
Other leading producers				
Other OPEC				
Venezuela			58.5	85
Nigeria			16.0	28
Indonesia			8.2	17
Ecuador			1.5	15
Gabon			0.7	9
Total OPEC			767.1	92
Rest of World:				
USA			34.1	10
Canada			8.3	13
Mexico			56.4	56
United Kingdom			3.8	5
Norway			11.6	20
USSR			58.4	13
Other Eastern Europe			1.5	10
China, People's Repub.			24.0	23
World total†			927.7	54
World total			1,011.8	44

* Including crude oil, shale oil, oil sands and natural gas liquids.

† World total less the USSR, the People's Republic of China and Eastern Europe.

Source: The Middle East and North Africa 1991

distribution of crude oil reserves in each country. This distribution, of course, affects production levels in each country, which in turn affect availability of foreign exchange and the establishment of development programmes. The availability of crude oil dictates the number and size of industry projects that a country can initiate. Saudi Arabia, which has the largest reserve, invested heavily in the refining industry, as explained previously.

On the other hand, Gabon is not expected to go downstream in the refining industry for the simple reason that its productive capacity is constrained by its limited reserves.

Conservation is another factor that affects the level of production. Countries with large reserves are less affected by this measure. For example, Saudi Arabia's production level is around 9.9 million barrels per day. If the country cut this level by 50 per cent, it would still not suffer financially. Gabon or Ecuador, however, whose production levels are a little over 200,000 barrels per day, would suffer substantially if they cut their production by the same percentage⁽¹⁾.

(1) OPEC Annual Statistical Bulletin, 1983

4.4 Gas Associated with Oil

OPEC countries possess a vast quantity of natural gas produced in association with oil. About 300 to 800 cubic feet of gas are associated with every barrel of oil produced in the Middle East.⁽¹⁾ OPEC holds about 40 per cent of the total world natural gas reserve.⁽²⁾ Methane (CH_4) is the predominant hydrocarbon component of natural gas. Methane constitutes approximately 52 per cent and 80 per cent of the volume of associated and dry gas, respectively.⁽³⁾ Because of its higher methane level, dry gas is more expensive to process and transport. Methane is liquified at very low temperatures (-161°C) compared with propane (C_3H_8), which changes to liquid at -42°C .

Gas reserves vary from one OPEC country to another as shown in Table 4.4. However, all countries have some associated gas, but not all of them have non-associated (dry) gas reserves. Natural gas reserves influence how far a country can expand its

(1) Crane (1978) p21

(2) OPEC Annual Report, 1983.

(3) Adnan Mustafa, (1981) pp, 104-105.

GAS : RESERVES, PRODUCTION AND TRADE (billion cubic metres)

Country	Reserves 1 Jan. 1989 (b.c.m.)	Production 1988 Gross - Including Gas Flared or Rejected (b.c.m.)	Gas Flared 1988 (b.c.m.)*	Gas Rejected to maintain Oil Field Pressure 1988 (b.c.m.)*	Exports of Gas by Pipeline or as LNG 1988 (b.c.m.)	Consumption - Methane 1988 (b.c.m.)
Saudi Arabia	5,020	45.2	3.3	3.00	nil	29.10
Kuwait	1,378	8.98	0.9	0.10	nil	9.59
Iran	14,200	40.5	4.0	15.00	nil	20.00
Iraq	2,690	10.68	4.51	nil	3.10	2.63
Abu Dhabi	5,180	16.98	0.30	2.00	3.18	9.74
					LNG to Japan	
Qatar	4,621	7.31	nil	nil	nil	6.47
Libya	722	12.50	2.58	4.00	1.06	4.44
					LNG	
Algeria	3,230	109.93	6.00	53.00	26.26	18.64
					both	
Nigeria	2,476	18.35	12.25	2.30	nil	3.80
Gabon	16	1.75	1.25	0.35	nil	0.10
Indonesia	2,464	51.70	4.30	8.90	24.58	13.44
Venezuela	3,000	37.90	3.60	11.90	nil	19.68
Ecuador	113	0.72	0.61	0.03	nil	0.08
USA	5,154	580.57	4.02	69.43	1.75	507.22
					to Canada	
Canada	2,637	130.64	2.74	15.35	35.91	62.69
					to USA	
Mexico	2,078	36.05	1.44	nil	nil	26.21
UK	590	53.80	2.24	2.50	nil	57.10
Norway	2,298	35.86	0.18	4.67	28.26	1.57
Netherlands	1,730	66.00	nil	nil	28.87	39.26
France	30	4.58	nil	nil	nil	28.52
Italy	290	16.63	nil	nil	nil	41.57
W. Germany	188	17.46	nil	nil	1.10	57.97
					to France, Austria and Switzerland	
Japan	33	2.10	nil	nil	nil	44.50
Australasia	2,573	21.37	nil	0.80	nil	18.65
USSR	42,500	799.60	20.00	nil	87.83	684.57
World total	116,283	2,368.23	92.41	209.16	265.05	1,959.47
OPEC total	40,229	372.26	45.52	102.40	60.36	143.43
OPEC % World total	34.5	15.7	49.25	49.00	22.80	7.3

Source: The Middle East and North Africa 1991

petrochemical and other gas-based industries.

Saudi Arabia has abundant associated gas; for every barrel of oil produced, about 800 cubic feet of gas can be gathered.¹ Figure 4.2 shows the gas gathering program, stages and linkages. This byproduct enables the country to expand its gas-based industry. Kuwait has no dry gas reserves, and its associated gas is not large due to its relatively low oil production. As a result, Kuwait's use of gas is limited to utilities **such as heating , cooking ,** and, to a certain extent, the fertilizer industry. Algeria does not face this constraint due to its significant reserve of non-associated gas, which is not affected by the level of oil production.

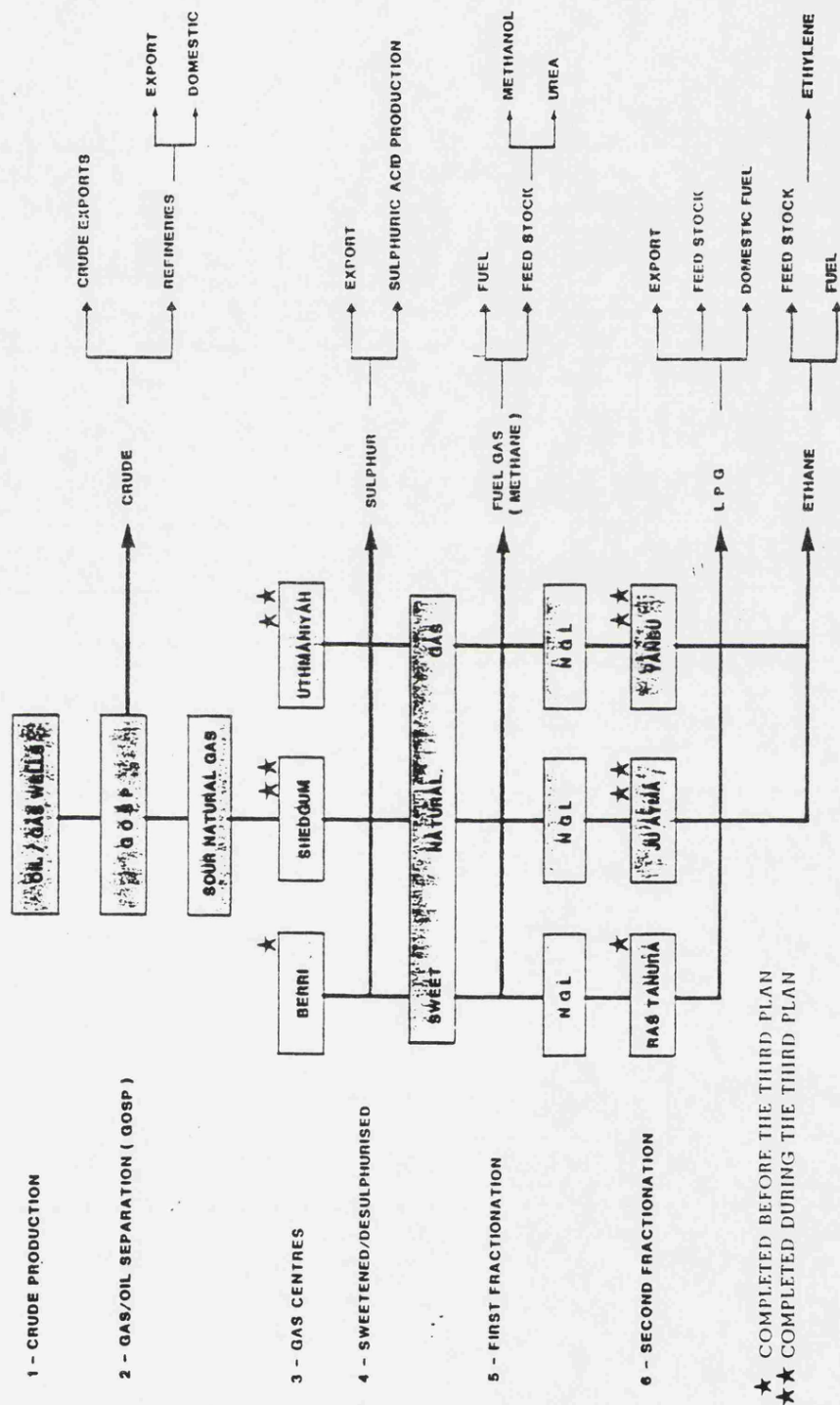
The abundant quantities of gas in some OPEC countries give them a favourable supply of cheap feedstock for their downstream ventures. This is supported by the high cost of transporting gas compared with transporting intermediate and final products. However, the disadvantages of cheap geographic location outweigh the advantages of cheap

(1) Kurt Hansen, (1978), "Investment and Location policies of Transnational in Petrochemicals", Proceedings of the OPEC Seminar on Downstream Operations in OPEC Member Countries... Prospects and Problems, (Vienna, October), p.67.

(2) Crane, p.20.

FIGURE 4.1

THE GAS GATHERING PROGRAM, STAGES AND LINKAGES



stock, which will be discussed in subsequent section.

4.5 The Importance of Natural Gas

Natural gas has become the most important alternative energy source to reduce dependence on oil as the only source of energy. Since 1974 energy experts pronounced gas to be an essential component of an "away from oil" strategy.

Western Europe's consumption of natural gas increased on the average by 4.7 percent yearly from 1974 to 1979, and in Japan at the rate of 25.7 percent, while the consumption of total energy increased annually by 2.2 percent and 1.5 percent respectively.

The USA experienced a decrease in consumption of gas on the average of 2.1 percent per year for the same period of time. This exceptional development in the USA distorted perception of actual trends, and the true value of gas as the best alternative to oil, especially when the USA continued to consume about half of world gas production.

Natural gas can replace oil in practically every field of use. Both oil and gas can be used as a raw material in the petrochemical industry, and have a wide range of uses in the industrial sector, in

producing electricity cooling and cooking.

The advantage of natural gas is its flexibility. The development of the gas pipeline has made it an easy fuel to handle. But the trend in favour of gas in some of the industrialised countries is due to its availability, reasonable prices and the lack of serious associated political problems. However the initial cost of developing large gas systems is very high, but once the system exists the running costs are relatively low.

The USA was the first country to rely on gas on a large scale, the USA was responsible for 92 percent of world production and consumption as of 1950. The expansion of the gas industry in Western Europe did not occur until the 1960's, from 1960 to 1970 gas consumption multiplied by a factor of seven. Japan did not begin to use gas until the 1970s.

4.6 The Domestic Use of Natural Gas

In fact, the domestic use of natural gas is an effective rational use that leads to the conservation of millions of barrels of oil yearly. Natural gas is clean, cheap and efficient, therefore, it will substitute for oil in electrical generation and in other industrial uses.

The sulphur products will be used domestically for sulphuric acid or alternatively, exported. The fuel gas (methane) will be utilized by industrial plants in the Eastern Province by water desalination plants and all industrial projects in Jubail and Yanbu.

"The huge gas collection will employ a work force of 30,000 in gathering, sweetening and separating the gas into the required steam and will require an installed electricity generating capacity of 4,000 megawatts".⁽¹⁾

In the future, illumination of the Eastern Province will depend on natural gas. Otherwise the expected increase in the desalination of sea water plants because of the lack of sweet water resources will increase utilizing natural gas in such plants.

4.7 The Impact of Population

Population is diversely distributed among the OPEC countries. It ranges from densely populated countries like Nigeria, Indonesia and Iran, to sparsely populated areas like the Gulf states. Population can be an impediment to development in two ways. First, if the country is sparsely populated, it will be compelled to import its labour force from abroad to conduct development programmes. Second, over populated countries suffer numerous problems that

(1) Crane, Planning the Future of Saudi Arabia, p.30

result in a low standard of living and low per capita income. OPEC countries face these problems when implementing their industrial development programmes. The OPEC Secretary General explained the problems of sparsely populated countries in the following way:

"I would cite countries like Kuwait, the United Arab Emirates and Qatar... where in the long-run, the need on the part of the State to import labour to operate plants and to provide that labour with free education, health and heavily subsidized electricity and water facilities can outweigh the advantage of the products themselves.... The foreign labour force in some cases might exceed the native population of that country".⁽¹⁾

The foreign labour force reached about 84 per cent of the total labour force in the Gulf states, as shown in Table 4.5. This problem of manpower shortage is not existent in the overpopulated countries such as Nigeria and Indonesia. Even so, having a low percentage of the population in the productive age (less than 18 years old) and the lack of expertise have made these countries dependent on foreign experts to help them operate their industrial ventures.

4.8 The Impact of Markets

Marketing petrochemical based products is one of the major issues facing the refining and petrochemical industries in OPEC countries. The projects were

(1) Jaidah, p. 16

TABLE 4.5

Selected Demographic Characteristics of the Gulf State Members of OPEC

	Kuwait	Qatar	Saudi Arabia	UAE
Total pop-ulation (000)	1440	230	8650	850
Annual population growth rate	6.2	3.7	3.1	11.7
Density of Pop-ulation/KM ²	80.8	20.2	4.0	10.3
Urban as of total population	88.4	88.7	20.2	84.0
Female as % of total	46.0	40.0	49.4	30.8
Foreign as % of total of age distribution	60.0	61.8	11.8	69.5
Under 15	39.6	36.8	46.7	28.2
15-49	55.4	56.4	42.3	64.5
50+	5.0	6.8	11.0	7.3
Labour force (000)	430	110	2,550	450
Foreign as % of total	69.7	81.1	43.0	84.8
Female as % of total	11.6	2.9	6.0	3.4

Source: The Resource Base for Industrialisation in the Gulf Cooperation Countries: A Framework for Cooperation, United Nations Industrial Development Organisation (UNIDO), 1983

planned in the early 1970s when the market was favourable. However, the international market now faces over capacity. Martin Quinlan of The Petroleum Economist explains:

"World capacity for high volume petrochemicals is well in excess of realistic assessments of future demand..... major oil companies are now showing serious losses on their chemical operations until capacity is brought more into line with demand, talk of recovery must be premature".⁽¹⁾

The refining industry is no exception. The large surplus of refined products due to the failure of world oil consumption to expand at rates predicted in the early 1970s caused serious losses for the refiners.⁽²⁾ Some studies estimate that the average operating rate of the refiners is about 60 percent of capacity in Europe; 73 percent in the United States; and not more than 70 percent in Japan⁽³⁾.

Nevertheless, various capacity increases are planned worldwide, especially in the OPEC countries, as discussed in the previous chapter.

(1) Martin Quinlan, "Chemical Profits Continue to Decline, The Petroleum Economist, July 1983, p.261

(2) "OPEC Refineries: Will It Pay to Export Products?" The Petroleum Economist May 1983, p.181

(3) Ibid

When talking about markets, the OPEC group is not homogeneous. Some countries have appreciable domestic market that could consume a large portion of their downstream products. On the other hand, the sparsely populated countries have no significant domestic market, and hence their downstream operations rely on export.

As a result of conservation measures, the industrialized countries have experienced a slow growth in energy demand since the late 1970's.⁽¹⁾ On the other hand, LDCs are expected to experience a far higher energy growth rate than the industrialised countries, since the LDCs started with very low per capita energy consumption.⁽²⁾ These countries will be an attractive market for the refined OPEC products, provided that the balance of payments in the less developed countries will allow them to keep importing refined products. The energy consumption of the developing countries is projected to grow from an equivalent of 3.7 million barrels of oil per day in 1990, for an average annual growth rate about 21 percent.⁽³⁾

(1) British Petroleum Company, British Petroleum Statistical Review of World Energy (1984) p.28

(2) Peter H. Spitz, "Outlook for OPEC Member Countries in Downstream Operation", OPEC seminar on Downstream Operation (Vienna: 1978)

(3) Abdul Amir Al-Anbari, "The Fundamental Energy Issues in the Developing World" paper presented to the OPEC seminar on Energy and Development: Options for Global Strategies (Vienna: 1981)

The petrochemical situation is similar to that of refined products. The growth rate for petrochemical consumption in industrialised countries is slow. Demand growth to 1990 in Western Europe is estimated to fall within the range of 1.5 to 2 percent annually.⁽¹⁾ In the United States, the demand for petrochemical products grew at a higher rate, around 10 percent annually, from 1950 to the early 1970s. however, this growth rate is now much lower, and this country's plants are operating below 80 percent of their designed capacities.⁽²⁾ Studies relate the slow growth in demand to low GNP growth, inflation, and the higher cost of energy.⁽³⁾ The population growth rates of the industrialized nations declined, which is another factor helping to slow the growth in demand for consumer goods and, with time, petrochemical products. On the other hand, the Third World countries are experiencing a high population growth rate which makes the LDCs a potential market for petrochemical products, provided that they are financially able to conduct trade with exporting countries.⁽⁴⁾

What has led to production overcapacities, whether in refined petroleum or petrochemicals? The

(1) Quinlan, P. 261

(2) Chemical Engineering News 2 April 1984, p.18

(3) Spritz, p.43

(4) Chemical Engineering News December 1984

answer is that when the oil-producing countries started their downstream programs in the late 1960s and early 1970s, demand growth was high in the industrialised world, and it was expected to grow at the same rate. However, when the seventh decade of this century came to an end, consumer behaviour changed, which might be the reason for present over capacity.

What are the options for the oil-producing countries? Despite the product's market stagnation, which might be temporary as some marketing forecasters predict,⁽¹⁾ some recommendations can be made to speed the development pace. It is important to choose a product with potential demand in the world market, especially now, when the markets face over capacity.

On the refining side, many U.S. refineries and, to some extent those in Western Europe, can handle only "sweet" crude oil, which is free of sulphur.⁽²⁾ A study by the U.S. Department of Energy estimated that hydrogen alone costs about \$1 to desulphurize one barrel of highsulphur crude.⁽³⁾ The desulphurization process uses large amounts of hydrogen, which can be

1. Spitz, p.39

2. Ibid

3. U.S. Dept. of Energy, Office of oil and gas, Trends in Desulphurization Capabilities, Processing Technologies, and Availability of Crude oil (Washington, D.C.: 1977) pp.2-3

provided from natural gas.⁽¹⁾ Because gas is an abundant resource in OPEC countries, it is economically feasible to implement this process in the producing countries and to ship the desulphurized oil to industrialized countries for further refining.

As far as the petrochemical industry is concerned, it is in the interest of OPEC countries to begin with products that require standard technology to process. Such plans should also concentrate on products that can be marketed regionally and within the LDCs; for example, ammonia is the main petrochemical in the fertilizer industry. It has a strong annual growth rate of demand in developing regions (about 10 Percent), especially in Asia. Demand for ammonia grows by about 4 percent in the industrialized regions.⁽²⁾ Moreover, the technology for this industry is evolving relatively slowly.⁽³⁾ Other products which may have important market prospects are liquified natural gas (LNG), liquified petroleum gas (LPG), ethylene and methanol. Any of these materials can be processed by a relatively standard single plant, without any need

(1) How to Upgrade Heavy Feeds, Hydrocarbon Processing, February 1984, p.81

(2) Chem. System Inc. The Future of Ammonia Business 1978.

(3) Spitz, P.28

to build huge, costly industrial complexes. It is better for the OPEC countries to start, by producing intermediate materials and exporting them for further processing since these intermediate products require relatively simple technology. Investing in intermediate products will solve the problem of having all stages of the petrochemical downstream operations completed in high-cost complexes. It will also simplify the marketing task. Mr Torii of the Mitsui petrochemical company of Japan addressed an OPEC seminar on the petrochemical industry about how the Japanese petrochemical industry has evolved over the past decades. He concluded by advising the OPEC countries:

"I feel that it is advisable for OPEC member countries, as they embark on the petrochemical business, not to aim at completion of grand complex in a single effort, but to start first with solvents, aromatics or bulk products going a step further than oil products; then to go into quantity production of monomers such as ethylene glycol, methanol, chemin and phenol; and finally proceed to polymers including polyethylene and polypropylene."⁽¹⁾

It is better to start with one or a few products rather than building huge petrochemical complexes that require investment in highly sophisticated technology the Third World lacks when inhering petrochemical industry.

1. Yasuji Torii, "Problems of Technology and Marketing: An Appropriate Approach for OPEC", Proceedings of the OPEC Seminar on Downstream Operations: Prospects and Problems (Vienna: 1978) p.151

Regional cooperation is another option open to OPEC countries. One of the constraints facing industrialisation in the Gulf states is the small domestic market. This problem could be overcome through specialisation rather than project duplication as now exists. In the case of the Gulf region, where the smallest population of OPEC members is located, it is agreed that regional cooperation will help them to alleviate the scarcity of labour and expand demand potentials.⁽¹⁾ Other alternatives may be feasible to deal with marketing problems.

4.9 Other Relevant Issues

The petroleum industry is a risk-taking industry. It requires high capital investment without guarantee that oil or gas will be discovered. A high degree of uncertainty always exists in the early stages of exploration. Development of oil or gas fields is a capital intensive task, especially if the fields are located off shore or in remote locations far from urban areas or export terminals. The processing of hydrocarbon resources is a dangerous endeavour as well. The materials are highly flammable and toxic; they are usually transported in pressurised vessels. This type of industry requires alert and skilled

(1) Taleb A. Ali, Regional Industrial Cooperation: Further Considerations (Kuwait: Industrial Bank of Kuwait, November 1984) p.24

personnel. In the oil producing countries this industry is a more difficult task than in the industrialised nations due to lack of technology, inadequate infrastructure, and remote geographical location with respect to the markets.

4.9.1 Lack of Technical Capabilities

Like the rest of the Third World, the OPEC countries lack the advanced technology necessary for sophisticated industrial development. Kuwait's oil minister stated:

"Downstream investments are highly technology-intensive with continuous changes in techniques and processes, thus adding a further cost factor which would reduce OPECs comparative advantage".⁽¹⁾

The costs of producing and constructing equipment and plants in OPEC countries are approximately 80 percent higher than in the industrialised countries.⁽²⁾ Because they lack technical expertise, the OPEC countries had to lease or buy various process licenses for their petrochemical industries. This situation will persist as long as research and development are overlooked by OPEC countries. Therefore, a logical approach is to start with licensed technology and then initiate R and D programs locally, searching for appropriate technologies to suit their needs.

(1) Remarks by Ali K. Al-Sabah, Oil Minister of Kuwait on Downstream Investment Proceedings of the OPEC seminar on Downstream Operations in OPEC Member Countries. Prospects and Problems (Vienna: 1978)

(2) Spitz, p.46

4.9.2 Inadequate Infrastructure

The Third World countries often possess weak, unreliable infrastructure to sustain economic growth. Lack of adequate infrastructure is one criterion used to designate countries as LDCs. This problem is one of the constraints against industrialisation, as expressed by Mr. Akhdar, a Saudi planning advisor: "What is vital is infrastructure. We must build that before we can industrialise".⁽¹⁾ Adequate roads, ports, airports and communication systems will help the economy grow and industrial ventures to flourish. Furthermore, suitable housing, education, and health care will improve the living standards of the countries' human resources which are important to development programs.

Todaro stated "The level of infrastructural development in a country is a crucial factor determining the pace and diversity of economic development"⁽²⁾ OPEC members, realising the importance of infrastructure in the development process, have given its construction a high priority. In the Gulf states, for example, investments in infrastructure constituted between 40 and 70 percent of development

(1) John K. Cooley "Saudi Arabia Planning Its Future", Christian Science Monitor 22 March 1976.

(2) Michael. P. Todaro, Economic Development in the Third World 2nd ed. (London: Longman, 1981) p.526

allocation.⁽¹⁾ However, this figure cannot be generalised to all OPEC members. In some countries like Nigeria and Iran, their inadequate infrastructure impedes economic development.

4.9.3 The Importance of Geographic Location

The location of natural resources is an important issue concerning exploitation and marketing of their processed products. Are the oil or gas fields off shore or on land and are they close to loading terminals or located in remote areas? These factors affect production costs, as in the North Sea and the oil fields of the Empty Quarter desert in Southern Saudi Arabia, where harsh weather and remote location keep production costs high.

The geographic location of OPEC countries affects the direction of oil and product movements. The largest portion of oil imports to the United States (approximately 42 percent) in 1983 came from Latin America, compared with only 12 percent from the Middle East. On the other hand Japan imported about 66 percent of its oil from the Middle East compared with only 4 percent from Latin America.⁽²⁾ Similarly,

(1) Howard Bowen-Jones "The Philosophy of the Infrastructural Development in the Arab Gulf States", in M. S. El-Azhary (ed), The Impact of Oil Revenues on Arab Gulf Development, (London: Croom Helm, 1984), p.33.

(2) British Petroleum Statistical Review of World Energy, June 1984, p.17

Western Europe imported about 40 percent of its 1983 energy requirement from the Middle East.⁽¹⁾ These figures indicate that location of the country with respect to the market for its products could be a key factor in the profitability of industrial projects. This issue should be considered carefully when conducting feasibility studies of industrial projects.

(1) Ibid

CHAPTER 5

PETROCHEMICAL INDUSTRY

5.1 INTRODUCTION

Petrochemical products are chemicals derived from a starting raw material obtained from petroleum or natural gas by "cracking" through subsequent chemical processing⁽¹⁾. Petrochemicals also may be defined as those which are made from petroleum feedstocks. Petroleum itself is a mixture of hydrocarbons and it is therefore to be expected that the production of petroleum chemicals will fall largely within the realms of organic chemistry. However there are some exceptions; such as in the production of ammonia, petroleum acts as the source of hydrogen and the end product is inorganic⁽²⁾. Eventhough the number of inorganic chemicals commonly made from petroleum is not large, the tonnage is considerable. As an example the world-wide production of ammonia and sulphur alone from petroleum source reached about 20 milliontons in 1979⁽³⁾.

The chemical industry became more important during World War Two, because many chemicals were used

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- (1) Clifford A. Hamble, Glossary of Chemical Terms (New York: Van Norstland, Reinhold, Ltd. 1976) p.207.
(2) Petroleum Chemicals, BP Handbook for Teachers, BP Educational Services, 1975, p.1.
(3) Ibid, p.1

for military purposes, which encouraged the chemical industry and accelerated its development. Therefore new products were produced and research and development of using alternative, cheaper and more practical raw materials mainly petroleum took place, to replace the old methods which were used before the war to make basic organic chemicals from coal. The United States was the only country at that time a petroleum producers, among the countries with an important chemical industries. When the oil from the new Middle East sources and the simultaneous expansion of oil refineries in the late 1940s, led to petroleum based products becoming the main Feedstock for Chemicals in the United States⁽¹⁾. The use of oil in the chemical industry was encouraged also by the characteristics of petroleum: its hydrocarbons are easier to separate into different organic chemicals than are other natural raw materials; petroleum also contains a greater number of hydrocarbons which can be used for different drilling industries and products. The primary petrochemical products are ethylene, propylene, butadiene and benzene.

Ethylene is the major chemical material to produce further important chemicals such as polyethylene plastics, ethylene glycol, styrene and

(1) Richard Frank Goldstin and A. Lawrence Waddams, The Petroleum Chemical Industry, pp. 10-12

others. The manufacture of ethylene depends on the choice of raw material such as natural gas which is one of the most economic and efficient to use. Ethane and propane can be obtained by liquifying natural gas to be used as a Feedstock. The first stage in the manufacturing process is the cracking stage where ethane and propane are subjected to high temperature in the absence of air to break down its hydrocarbon molecules into lower molecular weight. Then they pass through a special plant to be compressed, and the final stage is the purification from other gases.

Another important basic petrochemical material is propylene that can be obtained as a by-product of gasoline manufacturing processes or from ethylene plant through the cracking stage. It can be produced alone from propane gas by cracking in mix with a stream of other chemical grade materials. The most important propylene derivatives are films, fibres, detergents and plastics.

Butadiene is a product of butane (from NG) by the process of dehydrogenation process and can be manufactured from other chemical such as butylene or provided from hydrocarbon cracking, mainly as a co-product of ethylene. The reaction steps passed through are compression, coiling and absorption. It is flammable gas and used in synthetic rubber.

Benzene can be obtained from the oil refining process or from natural gas liquids, it is used to manufacture dyes, elastomes, styrene, plastic and medical chemicals. It is flammable and used as a solvent for gum and fats.

5.2 Characteristics of the Petrochemical Industry:

The petrochemical industry yields an important contribution to the nation's research and development effort, accelerating technological development and providing opportunities for professional employment in engineering, physics and related fields.

All these advantages of the petrochemical industry encouraged almost every nation to develop such industry, but the ability to develop it economically differs from one country to another. The following characteristics of the petrochemicals industry should be borne in mind in establishing a program of its development:

1. A high requirement of raw materials.
2. A high rate of technological change to continue efficiently with the lowest costs.
3. A high capital intensity.
4. A high degree of product homogeneity and standardization, continuity and stability of operations.

5. A high proportion of skilled labour, including scientists and technicians.⁽¹⁾

Petrochemical industries are very large and use sophisticated equipment. A large scale of operation is usually necessary to make the large plant operation economical. The high rate of capital and the existence of economies of large scale make it necessary to have large domestic markets which are more secure than foreign ones.

The petrochemical industry is extremely capital intensive. The capital investment per unit of output is very high and the capital labour ratio is more than other industries. For example, through 1973, the capital labour ratio ranged from \$20,000 to \$100,000 for each new job created.⁽²⁾ The production cost of energy represents the largest contribution per unit produced. For example the energy costs of polyethylene are 35 to 50 percent of total production costs, and for ethylene oxide, it is 45 to 75 percent.⁽³⁾

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1. United Nations, The First United Nations Conference on the Development of Petrochemical Industries (Report, 1966)
 2. The U.N. Industrial Development Organisation, The Petrochemical Industries (Vienna: U.S. Publication 1973) p.3
 3. The UN, Industrial Development Organisation, The Petrochemical Industries (Vienna: US Publication 1973) p.3

5.3 The Developed Countries Share in Petrochemical Industries:

The petrochemical products were first manufactured in Canada in 1945 by Polymer Corporation which produced synthetic rubber based on refinery gases. However up to 1950, there was relatively little production of petrochemicals outside North America. Europe started slow petrochemical development during this period, by the early 1950s the UK took the lead in Europe, and in 1954 it was responsible for over half of European total petrochemical production. In the later 1950s other European countries developed petrochemical industries, with the result that the size and the scope of these industries in West Germany, France and Italy at the end of 1950s were comparable with that of the UK. In 1960, Europe achieved a high growth rate in the petrochemical industry. But the most notable feature of the last twenty years was the rise of Japanese petrochemical production to the point where it was second only to that of the United States. Although Japan imports its fuel and raw material (oil and gas), it succeeded in the petrochemical industry because of its high technology, high skilled labour and its huge domestic market.

The world petrochemical industry grew faster than industry as a whole during 1960-1973. In the OECD area while total industrial production increased

during the period by 5.6 percent annually and chemical production by 9 percent, petrochemical production growth rate range between 10 percent and 17 percent.⁽¹⁾ The production of four basic petrochemical products (ethylene, propylene, butadiene and benzene) went up from 7.7 million tonnes to 51.1 million tonnes between 1960-1973⁽²⁾.

The world production of the main basic petrochemicals between 1965-1976 is shown by Table 5.1. The USA was the leading country, followed by Western Europe and Japan; the USA contributed over 50 percent of total world production in 1965, but dropped to 30 percent in 1976. This was due to the increase of petrochemical production in the rest of the world, especially in Western Europe and Japan. In 1976 Western Europe passed the USA in propylene production, and contributed 37.2 percent of total world production, compared with 32 percent from the USA.

The progress of petrochemical industry resulted from the following important factors: first is the availability of abundant supplies of oil and natural gas which were very cheap; second the rapid general economic growth associated with great expansion in the

(1) The Petrochemical Industry Trends in Production and Investment to 1985, Organisations for Economic Co-operation and Development, OECD 1979, p.7.

(2) Ibid, p.7

TABLE 5.1

**WORLD PRODUCTION OF THE MAIN
BASIC PETROCHEMICALS
(Thousands of Tons)**

	<u>1965</u>	<u>1970</u>	<u>1976</u>
Ethylene			
United States	4,600	7,700	9,900
Western Europe	2,000	5,950	9,600
Japan	900	3,050	3,800
Others	<u>500</u>	<u>1,800</u>	<u>2,700</u>
Total	8,000	18,500	26,000
Propylene			
United States	2,400	3,900	4,400
Western Europe	1,100	3,280	5,100
Japan	700	1,850	2,600
Others	<u>200</u>	<u>500</u>	<u>1,600</u>
Total	4,400	9,530	13,700
Butadiene			
United States	1,100	1,400	1,500
Western Europe	400	880	1,400
Japan	100	450	590
Others	<u>300</u>	<u>400</u>	<u>1,400</u>
Total	1,900	3,130	4,890
Benzene			
United States	2,700	3,900	4,500
Western Europe	1,450	2,750	4,100
Japan	380	1,570	1,900
Others	<u>250</u>	<u>600</u>	<u>2,800</u>
Total	4,780	8,820	13,300
P. Xylene			
United States			1,500
Western Europe			750
Japan			550
Others			<u>300</u>
Total			3,100

Source: UNIDO, 12 December 1978, "First World-Wide Study on the Petrochemical industry 1975-2000", p.21.

chemical industries; and third is the large number of innovations and new techniques that created new products such as plastic, synthetic rubber and fibres.⁽¹⁾

The oil price crisis in 1973 and the recession that followed in 1975 affected the production of petrochemicals and the growth rate experienced a sharp decline. For example in 1974 ethylene production advanced by only 6.1 percent compared with 11.0 percent in 1970-73, and propylene production advanced by only 3.8 percent compared with 13.7 percent in the same period, also benzene declined by 5 percent and butadiene declined by 7 percent in the same period⁽²⁾.

In Western Europe, the slow down in petrochemical production started in 1970, 4 years before the oil crisis⁽³⁾. Since then, the production of petrochemicals has grown at only 2.5 to 3 percent annually on average, compared with 5 to 6 percent in the previous twenty years. This was the result of external and internal factors: Externally the slow down caused by the increased competition from Japan

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- (1) Organisation for Economic Cooperation and Development (Paris: The Petrochemical Industry, 1979), p.7.
 - (2) The Petrochemical Industry, Trends in Production and Investment to 1985, Organisation for Economic Co-operation and Development, OECD 1979, p.11.
 - (3) Petroleum Economist, November 1972, p.416.

and other communist countries⁽¹⁾. Internally, the increased levels of inflation, the growing demand by unions for more power and influence in the running of both publicly and privately owned industry, and growth in the relative size of public sector expenditure which played a major role in increasing costs of both the construction and entire operation of the petrochemical industry⁽²⁾.

During the period 1975 to 1979, petrochemical industries regained a steady growth rate of about 5 percent annually and production was still dominated by the industrial nations⁽³⁾. The shares of the US, Europe and Japan in the production of main petrochemical products through the period 1960 to 1973 are shown by Table 5.2.

The petrochemical industry future in the developed countries is threatened by a problem of decline in the reserve to production ratio of gas. The US annual production of NG decreased substantially in 1977. This makes the US a major importer of LNG from Algeria of about 1,000 million cubic feet per

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- (1) Herman H. Stenger, The Problems and Pressures on the European Chemical Industry, in the Chemistry and Industry, 6 December 1980, pp.903-906.
- (2) Chemistry and Industry No.22, 20th November 1976, pp. 968-969.
- (3) Organisation for Economic Cooperation and Development (Paris: The Petrochemical Industry, 1979), p.8.

TABLE 5.2

Contribution of the U.S., Europe and Japan in the
Production of Main Petrochemicals: 1960-1973

		1960					1973		
		Ethylene	Propylene	Butadien	Benzene	Ethylene	Propylene	Butadiene	Benzene
United States		76.2	74.0	74.4	69.0	42.3	36.3	45.3	44.4
Western Europe		21.3	26.0	18.7	25.0	40.3	40.9	36.6	37.2
Japan		2.5	-	1.9	5.0	17.4	22.8	17.9	18.4
TOTAL		100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: Organisation for Economic Cooperations: The Petrochemical Industry 1974, p.9

day⁽¹⁾. The UK supply of gas will be sufficient only up to the 1990s, where as the North Sea natural gas reached its peak average of 4,000 million cubic feet a day from 1977 to 1980. The production of gas in 1990 is expected to fall to an average of about 1,500 million cubic feet. The main dominant gas reserve in the world is that of Russia, followed by the reserves in the Middle East. The Netherlands exported large amounts of gas to northwest Europe over the past years, but its contribution of gas supplies in the future seems limited. Many West European countries will import natural gas from Russia through pipeline projects, but this still is a matter of cost, the natural gas price, and other considerations.

5.4 Developing Countries Petrochemical Industries

The petrochemical industry in developing countries was very limited during the fifties and sixties. Through the sixties developing countries such as the Latin American and the Far East showed interest in petrochemicals, but their plants were very modest to provide for the domestic market needs. By the seventies other countries started to establish small and medium size plants. Among these countries Saudi Arabia, Iran, Algeria, Brazil and Venezuela.

(1) Peebles, M. Evaluation of the Gas Industry, New York: New York University Press, 1980, p.84.

The main reasons which encouraged these countries to enter the petrochemical industry were:

- (1) The availability of local raw materials, mainly gas which used to be flared in these countries. Petrochemicals seemed an attractive proportion to utilise this valuable source.
- (2) The increase of oil prices in 1973 and after, increased the revenue of these countries and helped them to invest heavily in large scale-heavy industries such as the petrochemical without incurring the problem of foreign exchange shortages.
- (3) The rapid increase in petrochemical products which most of developing countries import from industrial countries.

The petrochemical industry in developing countries differed from one country to another depending on the following factors:

1. The availability of skilled labour.
2. The availability of adequate general infrastructure.
3. The stability of political conditions.
4. The availability of raw materials such as oil and gas.
5. The availability of local and international

markets for petrochemical products.

In Saudi Arabia as in other big oil producing countries an important factor for the petrochemical industry is that when economies of scale are operative, the relative share of raw materials in total cost rises with increasing scale of production. Thus while capital cost per unit of production is reduced, the contribution of each unit cost of raw material is increased, thus improving the comparative advantages to those countries richly endowed with the requisite raw material.

In November 1964, the First United Nations conference on the development of petrochemical industries in developing countries was held in Iran. The conference discussed major problems of petrochemical industries facing developing countries. It concluded that small local markets, a foreign exchange shortage and lack of skilled labour force were the major constraints upon this industry, hence the following suggestions were presented:

1. Labour: the scarcity of highly qualified personnel makes it necessary to plan a training program to alleviate this problem in the long-run. The assistance of the educational institutions of the industrialized countries and

cooperation of engineering and construction enterprises are vital considerations.

2. Capital: Could be obtained through the contribution of equipment credits and loans from other countries, joint ventures with foreign companies and local capital resources, both private and public.
3. Market: The limited size of the domestic market is a major constraint which can be solved by exporting large shares of the output (if possible) to international markets or through regional arrangements to neighbouring countries.⁽¹⁾

The developing countries lack wide domestic markets for petrochemical products. This is because of the underdevelopment of their economies and the low per capita income of their population. The capacities of basic petrochemical products in the developed world, and their share of in world total capacity in mid 1977 is shown in Table 5.3. Total capacity of the developing world for petrochemical products was only 5.8 percent of the world total.

1. The U. N. Industrial Development Organisations, Petrochemical Industry p. 14

TABLE 5.3

CAPACITY OF BASIC PRODUCTS IN THE DEVELOPING WORLD
IN 1977 (IN 000 TONNES PER YEAR)

Area	Ethylene	Propylene	Butadiene	Benzene	P.Zylene	O. Xylene	Methanol	TOTAL
North Africa	120	-	-	-	-	-	100	230
E and W Africa	-	-	-	-	-	-	-	-
South Africa	200	-	20	-	-	-	17	237
Middle East	190	40	33	-	-	-	54	317
South Asia	192	100	36	69	17	-	33	447
East Asia*	480	215	77	134	42	-	585	1533
Pacific Area	290	80	34	-	-	-	33	437
Latin America	1455	418	205	349	100	75	264	1411
Total	2927	853	405	552	159	75	1096	6067
Developed World	36080	19473	5635	18212	4091	2051	12221	97763
World Total	39007	20326	6040	18764	4250	2126	13317	103830

*Excluding Japan

Source: First World-Wide Study on the Petrochemical Industry 1957-2000, UNIDO, 12th December 1978, p.221.

5.5 Financing Industrial Development

The Saudi government established two funding agencies to encourage industrialisation, the Public Investment Fund (PIF) and the Saudi Industrial Development Fund (SIDF). The public Investment Fund (PIF) was established in 1971. It provides funding only for government or mixed sector (government and private) investment, at interest rate between 3 percent and 6 percent. It mainly makes huge loans to projects such as SABIC, Petromin, and SAUDIA (the Saudi National Airlines). The PIF total loans \$11.37 billions in 1971 to the end of 1984 and in June 1986 the total loans were \$11.63 billion. In certain circumstances apparently, the PIF does not demand loan repayment until projects are making an operating profit.

The Saudi Industrial Development Fund (SIDF) provides short-term and long-term loans up to 50 percent of the project cost to national Saudi firms on an interest-free basis, although there is 2 percent annual service charge. In case of a joint venture with foreign partners, the same privileges as for pure Saudi firms are provided as long as Saudi participation in equity represents 50 percent or more. However, when the Saudi participation is less than 50 percent then the loanable fund would decrease pari passu.

The SIDF was established in 1974 and up to 1984, the total loans reached \$11.78 billion. In June 1986 SIDF had \$11.5 billion in outstanding loans. However, SIDF has been the government's channel for funding electricity and water utilities so by the same period, June 1986 SIDF disbursed \$19.71 billion for electricity, gas and water, a high percentage of the outstanding loans. The industrial sector received more support than any other sector of the economy.

5.6 Other Financial Incentives

The Saudi government has introduced many measures designed to limit the financial burdens upon the new industrial enterprises. Industrial projects with at least 25 percent Saudi equity participation are free from income and company taxation for a period of 10 years after commencement of production.

Exemption from customs duties on imports of raw materials, machinery and spare parts. Also the government is prepared to introduce 10-20 percent advalorem tariff on competing imports.

The priority is given to Saudi products in public sector purchases. The industrial estates have been built and sites are accessible to industrial projects at very low rentals. The estates utilities include water, storm drainage and sewerage systems, power

supplies, telephones, roads, and community facilities such as mosques, banks, police, post offices, medical services, shops and restaurants. Each industrial estate contains a central workshop capable of manufacturing some spare parts for factories located in the area.

The Saudi Arabian Basic Industries Corporation (SABIC) a government-owned agency offered the following attractive package for prospective partners:

1. Each partner puts up 15 percent equity investments, while 60 percent of the remainder would be a loan from the government provided by the Public Investment Fund (PIF) at a 3 to 6 percent interest rate. The 10 percent is to be raised in the international markets.
2. The foreign partner is entitled to get 500 barrels of oil a day for each \$1 million of real investment for a period of up to 19 years.
3. The Saudi government sells the participants the feedstock at 50 cent per BTU, for the first stage of the plant start-up.

5.7 Subsidies:

Subsidies can be defined as any form of government aid that is directly or indirectly granted

to firms to reduce their production cost below the real cost.

The Saudi government top priority is the social well-being of all its citizens, this can be seen in the provision of utilities to businessmen and individuals alike at prices much below their actual cost. Also it provides free social services to both consumers and producers.

The government of Saudi Arabia subsidises the petrochemical industry to encourage the industry to stay in business and expand. It also encourages the private sector to invest in the petrochemical industry. The government subsidies will continue so that the petrochemical industry can be competitive in the international market. However subsidies are not a unique policy of Saudi Arabia government. The industrialised countries subsidise their economy and the industrial sector in particular.

The most subsidised factor of production by the government of Saudi Arabia is capital cost. Subsidies can be measured by taking the average rate of interest provided to the petrochemical industry by the public loans which is about 4.5 percent while the commercial banks loans at 10 percent. So the difference between the interest charged by the commercial banks and that

of public loans is the state subsidy. Thus subsidies are calculated to be $(10\% - 4.5\% = 5.5\%)$ multiplied by the size of the public loans.

Other factors of production are subsidised by the Saudi government such as natural gas, utilities, export terminals and roads. Even with the elimination of subsidies the Saudi petrochemicals still competitive internationally because of the feedstock comparative advantage.

5.8 The Industrial Cities, Jubail and Yanbu

In 1960, the Saudi government was already negotiating with foreign oil companies concerning the development of the petrochemical industry. Since these companies showed little interest, other ways had to be found to attract investment. In 1962 the General Petroleum and Mineral Organisation (Petromin) was established precisely to undertake hydrocarbon projects that did not attract private investors. In 1965 the Saudi Arabian Fertilizer company (SAFCO) was established to produce ammoniaurea - not strictly speaking, a petrochemical. In the beginning the plant was plagued by technical difficulties, management problems, and the falling world prices of Urea. However, the natural-gas feedstock, water and electricity were provided at heavily subsidize prices, and at the same time the government purchased the

output for use in its overseas aid program. Eventually the price of Urea began to rise, and in 1976 SAFCO took over the exclusive management from Occidental Petroleum. Since that time SAFCO has started to show a profit - \$35 million in 1979. In the first six months of 1980, 145,084 tons of Urea were produced.⁽¹⁾

Currently, the petrochemical industry is in two industrial cities, Jubail on the Arabian Gulf, and Yanbu on the Red Sea.

Jubail is the most advanced of the two industrial cities with a planned industrial area of 900 square kilometres. Yanbu is the less advanced of the two, with planned industrial area of 150 square kilometers.⁽²⁾

Jubail was chosen mainly because of its location near cheap energy resources and raw materials for the

(1) Hambleton Saudi Arabia Petrochemical Industry in 1980s p.51

(2) The Royal Commission of Jubail and Yanbu, Annual Report, 1979 (Riyadh, Royal Commission, 1979), p.16

petrochemical industry. This was one important economic factor which reflected the economic feasibility of intensive petrochemical industry in Jubail. The absence of transportation costs of raw material is another cost advantage beside the low price of oil and gas. Since petrochemical products are mainly for export, Jubail looks over deep-water areas on the Arabian Gulf that makes it adequate for shipping movement.

Yanbu was selected because of its excellent geographic location as a centre point and proximity to potential markets for export to Europe through the Suez canal. At the same time, it is located nearly in the middle of the major cities of the western province such as Jeddah Mecca and Medina. Connecting Yanbu with oil and Gas pipelines saves the oil ships thousands of kilometres around the Arabian peninsula from Jubail to Yanbu. This also gives the Saudi oil, petrochemical and other industries special advantage in a situation of political problems in the Arabian Gulf area strategic benefits. More specifically, if a state of emergency was imposed on the shipping movement in the Gulf, Saudi Arabia would have the advantage of being able to export oil and NGL through Yanbu.

In addition to the above advantages of the two industrial centres, the government believes in other fringe benefits, both economic and social, to be derived from the dual industrial centres: they will create training jobs for thousands of unskilled labourers and highly skilled craftsmen and generate industrial trade serving the primary hydrocarbon industry. Dr. Farouk Akdar, Secretary General of the Royal Commission for Jubail and Yanbu, stated:

"The new hydrocarbon industries will create new growth poles" in the Eastern and Western province by attracting a wide range of ancillary industries and fabricating facilities to Jubail and Yanbu. These industries will produce by-products of the petrochemical plants, steel mill and refineries and provide goods and services needed by the industrial complexes and communities at both cities."⁽¹⁾

The industries which will be built in both industrial centers have three main categories, primary industries, secondary industries and support industries.

5.8.1 Primary Industries

These industries represent the heavy processing industries which are energy - and capital - intensive and serve as the foundation for the industrial

(1) Farouk M. Akhdar, The Philosophy of Saudi Arabia's Industrialisation Policy (Boulder, University of Colorado, ICEED 1980) p.9

development of the Kingdom and, in particular, Jubail and Yanbu. The total industrial program for both cities implies the construction of petrochemical fertilizer, iron, steel and aluminum industries in addition to new oil refineries. Five petrochemical, two fertilizer, one iron and steel, and one aluminum projects will be located in Jubail. These industries will occupy an area of 50 square kilometers, including two refineries.⁽¹⁾ In Yanbu the other industrial city, one petrochemical plant and one NGL plant and exports refinery.

5.8.2 Secondary Industries

Secondary industries are the industries which use the products produced by the primary industries as raw material. They form the domestic market for the products of primary industry. Basically, they consist of manufacturing, fabricating facilities for by-products of refineries (rubber, paint, insulation, solvents, nylon, detergents and polyester). The petrochemical products will create industries to produce nitrate fertilizers, antifreeze, adhesives, plastic products, bleaches and others. Steel plant and aluminum plant will generate wide downstream

(1) The Royal Commission of Jubail and Yanbu, Annual Report, 1979 (Riyadh, Royal Commission, 1979, p.16)

industries, such as bar, wire, plate, housewares, furniture and pipes. These secondary products will be marketed domestically and overseas.

5.8.3 Support Industries

Support industries will be created to provide goods and services to the primary and secondary industries, other businesses, and to the general public at Jubail and Yanbu. Support industries will contribute through many activities such as construction material supply, industrial services establishment, public transportation, centres and repair shops.⁽¹⁾

5.9 The Community

According to the planned capacity of primary, secondary and support industries, it is estimated that in twenty years Jubail will have a population of 370,000 persons and Yanbu will have more than 150,000 (including foreign labour and Saudis with their families).⁽²⁾

In developing industrial projects, the

(1) The Royal Commission of Jubail and Yanbu Annual Report, 1979 p.10

(2) Ministry of Planning, The Third Development Plan, p.241

government believes in economic freedom and the importance of private investors through free competition. It encourages all elements of the society to share the industrial development by offering all incentives to achieve diversified industry. When the size of desirable investment is large and beyond the capacity of private sectors, the government itself underwrites such investment. Most of the non-oil manufacturing is in the private sector which receives much support and encouragement from the government. The incentives can be summarized as follows:-

1. Provision of assistance in selecting location, in preparation of economic feasibility and evaluation.
2. Providing land in industrial estates with very low annual rental. These estates are supplied with utilities which are offered with low prices for both electric power, water and fuel.
3. Exemption of imported equipment and materials from custom duties, imposing of protective custom tariffs on competitive imports, and pure Saudi companies are exempted from company taxes.
4. Giving preference to local producers in

government purchases.

5. Offering loans by the Saudi Industrial Development Fund (SIDF) up to 50% of total cost of an "administrative fee" of 2%.
6. Providing assistance for the exportation of products and granting subsidies for training Saudi labourers.⁽¹⁾ Despite the key role of the private-sector investors, the government involved itself directly in the basic heavy industry. This direct involvement was undertaken because of the relationship between hydrocarbon policies and the projects, the need of large scale capital, and other requirements:-

"The large amount of capital required, the long-lag time between planning stage and profitable operation of basic industry makes government involvement important. Moreover, government's close tie to hydrocarbon policies and projects make its involvement logical and unexceptional."⁽²⁾

Hence all petrochemical and other basic heavy industries which will be implemented by the government through the Saudi Arabian Basic Industries Corporation

(1) The Industrial Studies and Development Centre, A Guide to Industrial Investment in Saudi Arabia (Riyadh, 1977) pp. 35-38

(2) Ragaei El-Mallakh, An overview of the Third Development plan in Saudi Arabia p. 19

(SABIC).

5.10 The Saudi Arabian Basic Industries (SABIC)

SABIC was formed by royal decree in 1976 to establish a series of capital-intensive basic industry projects under the ministry of Industry and Electricity⁽¹⁾. SABIC has formulated arrangements for a joint venture with some steel and other hydrocarbon industries. It was provided with an initial capital of SR 10 billion (3.3 billion dollars) to start the hydrocarbon based industries included in the second plan⁽²⁾. However, SABIC has the ability to implement and realize industrial projects costing several times the initial capital through its equity sharing from foreign partners, loans from commercial banks and substantial parts from the public Investment Fund.

5.10.1 SABIC Objectives are:-

1. to develop the Kingdoms' natural resources of hydrocarbons and minerals by converting these into higher values industrial products,
2. to furnish the private sector with primary and intermediate industrial products that can be used further to diversify the national economy;

(1) The Royal Commission of Jubail and Yanbu, Annual Report, 1979 p.2

(2) Ministry of Planning, Third Development Plan.

3. to develop Saudi human resources through rearing a generation of technically oriented young men, trained in working in industry and capable of the responsibilities of industrialisation.

According to an interview in Petroleum Review, May 1987, with SABIC Managing Director, Ibrahim Bin Salamah, SABIC's goal outside the Kingdom is "a 5% share of the world's chemical markets by the end of the 1980s and perhaps a 15% share by the end of the next decade".

5.10.2 SABIC Projects:

The first group projects are:

Petrochemicals:

- Saudi Methanol Company (AL-RAZI)
- National Methanol Company (IBN SINA)
- Saudi Petrochemical Company (SADAF)
- Al-Jubail Petrochemical Company (KEMYA)
- Saudi Yanbu Petrochemical Company (YANPET)
- Arabian Petrochemical Company (PETROKEMYA)
- Eastern Petrochemical Company (SHARQ)

Fertilisers:

Saudi Arabian Fertiliser Company (SAFCO)

Al-Jubail Fertiliser Company (SAMAD)

Metals:

Saudi Iron and Steel Company (HADEED)

Jeddah Steel Rolling Mill Company (SULB)

Capital investment in the first group of its projects (see above) amounts to around SR 38bn, and the ownership of the first plant generation plants was on a 50% SABIC 50% foreign partner basis with the foreign partners agreeing to market a certain percentage of output for a period. Funding was 15% SABIC, 15% joint venture partner, 60% Public Investment Fund (at 3-6%) and 10% commercial.

It was not easy to build these world scale plants in a desert environment and, according to SABIC, they were all completed ahead of schedule and under budget. All the first generation plants are operating at full capacity and to the admiration of foreign chemicals engineers extremely well.

The second group of companies are:-

- National Industrial Gases Company (GAS)
- National Plastic Company (IBN HAYYAN)
- Saudi European Petrochemical Company (IBN ZAHR)
- National Chemical Fertiliser Company (IBN AL-BAYTAR)

The second group of companies have varying percentages of SABIC ownership SABIC has already sold parts of some of these to the private sector

and plans to sell more. The second generation plants are intended to provide product for local and regional consumption, with exception of the MTBE plant which is at present fully export oriented.

SABIC Gulf-based joint ventures are (all in Bahrain)

- Bahrain Aluminum Smelter (ALBA)
- Gulf Aluminum Rolling Mill Company (GARMCO)
- Gulf Petrochemical Industries Company (GPIC)

A net profit was realised by SABIC and its affiliated net profit in 1986 SR 200m, up from 1985's SR147.8m and 1984's SR 34.3m. SABIC marketed 7.33m tones of product in 1986 75% of which was exported to international markers. The 13 plants produced 7.615m tons in 1986, compared with 6.325m tons in 1985 and 2.78m tons in 1984. SABIC produced 2.88m tons of chemicals in the first half of 1986, of which 741,000 tons were fertilisers, 499,000 tons plastics, 643,000 tons other chemicals and 975,000 tons steel products.

The private sector is interested in chemicals, and SABIC is having to align its strategic thinking on the next period. As a majority government-owned company, it has an obligation under the fourth plan to

stand back and let the private sector take up projects. It has equally to show not just an operating profit but a return on investment.

5.10.3 The Chemicals Sector Developments:-

Saudi Arabia is now producing worldscale petrochemical products. In the past few years SABIC's primary industries have come on stream and are being sold on world markets. SABIC is becoming more experienced at running the base plants and a large proportion of Saudi are now employed in the plants at both cities Jubail and Yanbu. In SABIC PETROKEMYA for instance, Union Carbide acts only as advisors, it does not do the technical management. At one point Eastern Petrochemical Company (SHARQ) had 187 Japanese employees; now there are only 87 with Saudis taking their place. The concept of the work ethic is coming in and the trained Saudis are bright and effective.

SABIC has set up a number of plants in the intermediate chemicals sector, of which it is selling off some percentage to the private sector. The Saudi Private Sector is looking hard at the products of these plants to determine what further downstream or end products it can manufacture. The government is asking for private sector investment now but the business community see the returns on investment over a long time scale. However, it has been interesting

to see the gradual involvement of the Saudi Private Sector in chemicals development.

5.10.4 SABIC and the Private Sector:

Saudi and foreign business are optimistic about the medium or long term future for the Saudi chemicals "There is plenty of potentially profitable projects in the \$100-\$300m capital range". The only question is how to attract Saudi and foreign investment to the two cities Jubal and Yanbu. The MIE, with the Ministries of Finance and National Economy, and of Commerce, are talking exhaustively about incentives, facilities and more subsidies.

The philosophy of SABIC is that it should build the base and those intermediate chemical blocks which in size and cost beyond the private investment, such as the polystyrene unit, the oxygen and nitrogen plants or the PVC plant (IBN HAYAN). Once these are built it might invite some private investment, as with (IBN HAYAN) and the gases plant (GAS). This view makes good theoretical sense but the flaw is that SABIC needs sales of profitable commodity chemicals.

Some compromise has now apparently been reached between government and the business community: any project(s) which SABIC has initiated and publicly got to feasibility study stage SABIC will keep, and it

might invite some private sector participation. Thus SABIC is likely to continue with propylene and polyethylene production. But in any case SABIC does not have unlimited access to funds. Its projects have been financed by the Public Investment Fund (PIF). Public Investment Fund also has limited resources, though some of its loans are due to start being repaid.

For buying SABIC feedstock the pricing structure stated by SABIC that private business will receive feedstocks at world prices netted back to Saudi Arabia. Cost advantages will lie only in low if any transportation or warehousing costs; technical services will be immediately available and supplies secured through long-term contracts. However the Ministry of Industry and Electricity (MIE) when considering how to encourage the private sector would like to insist that private enterprise should get feedstock below world prices. The current projects could go ahead on the SABIC price basis and alternative subsidy structures can be created.

The government stepped in and ruled that SABIC must be prepared to sell up to 30% of its product locally, because buying and obtaining feedstock from SABIC is not easy yet, as SABIC has been unwilling to vary its established marketing strategies and sell in

the Kingdom. This will require some work on product lines and metering stations at Jubail and Yanbu which at present run uninterrupted to the export terminals.

5.10.5 The Joint Venture Partners. (1)

5.10.5.1 SABIC/Mobil project:- The joint venture between SABIC and Mobil oil company was signed on April 19, 1980, to be located in Yanbu. The capital cost of this project would be about SR 7000 million (\$2,000 million). SABIC and Mobil will be partners, each holding 50% of the equity. Each partner is expected to provide 15% of the capital cost in cash. The remaining 70% is to be provided by the Public Investment Fund of Saudi Arabia (60%) and by private banks (10%).

This project will use ethane gas as feedstock to produce 450,000 tons of ethylene, 200,000 tons of low density polyethylene and 200,000 tons of high density polyethylene annually. About 3,000 people will operate the project 40% of the employees will be Saudis and 60% will be expatriates; by 1990 it is hoped that these percentages will be reversed. The project at Yanbu would market their product in Europe, United States, Arab World, Africa and in Saudi Arabia itself. Three quarters of the sales will be handled

(1) The Saudi Arabian Basic Industry Corporation, Report (SABIC, 1978)

by Mobil. When the plant was at full capacity, this would mean that Mobil would increase its petrochemical production by one third.

5.10.5.2 SABIC/Shell Project:-

SABIC and Shell oil company formed the Saudi petrochemical company (SADAF) in September 1980 to be located in Jubail.

The capital cost of this project was estimated to be 3,000 million dollars. This project uses ethane and methane to produce 656 tons of ethylene, 281,000 tons of crude industrial ethanol, 295,000 tons of styrene; 454,000 tons of ethylene dichloride; 377,000 tons of caustic soda; 330,000 tons of chlorine and finally 327,000 tons of ethyl benzene.

5.10.5.3 SABIC/Dow Project:-

The main American chemical corporation, Dow Chemical, is a relative newcomer to Saudi Arabia. SABIC and Dow chemical established Arabian Petrochemical Company (petrokemy) in May 1981. The cost of this project was \$1,300 million to be located in Jubail. The basic feedstock to be used would be ethane gas to produce 500,000 tons of ethylene, 68,000 tons of low density polyethylene, 300,000 of ethylene glycol, and 105,000 tons of high density polyethylene. This plant should be virtually identical with one

recently completed in Canada.

5.10.5.4 SABIC/Exxon Project:-

On April 26th 1980, the final agreement was signed between SABIC and Exxon chemicals and the plant to be located in Jubail with an estimated cost of \$1,100 million. It will use ethylene as feedstock to produce 240,000 tons of low-density polyethylene annually. The project requirement of ethylene will be supplied by the SABIC/Shell project.

5.10.5.5. SABIC/Japanese Consortium Project:-

On November 1979, the initial agreement was signed between SABIC and a number of Japanese, including Mistubishi Gas, Sumitomo Chemical and C. Itah, to launch a joint venture methanol company in Jubail with an estimated cost of \$268 million, the feedstock that it will use is natural gas to produce 60,000,000 tons of methanol annually.

5.10.5.6 SABIC/Cleanse - Texas Eastern Project:-

Methanol plant in Jubail is a joint venture between SABIC and Cleanse Corporation and Texas Eastern. The cost of this project is estimated at \$350 million. It will use local methane to produce 370 tons of methanol annually.

5.11 Why Joint Ventures: The Saudi Government View

The Saudi government is looking for certain benefits from joint ventures:

1. Long-term commitment from foreign companies to help the government create a wider economic base in the country.
2. To reduce long term dependence on crude oil sales and to provide Saudis with careers, as well as jobs by industrialisation outside the hydrocarbon sector.
3. Transfer of technology and management skills and training of Saudis at various skill levels.
4. During a business downturn or in difficult business circumstances foreign companies with equity in Saudi/foreign ventures are less likely just to walk away.
5. Foreign companies with equity in the country are expected to help with the development of the Kingdom and to be responsive to the country's needs and the government objectives.

5.12 Why Joint Ventures: The Foreign Company's View:

Foreign companies invest in Saudi Arabia for many reasons; among them are the following:

1. The foreign companies fear that if they do not invest, then other companies in their product line will do so when the production reaches a certain level in relation to the overall demand, the government of Saudi Arabia may put quotas or tariffs on imports and foreign companies without the local manufacturing base may lose market share and even the market.
2. The foreign companies realise that being on the spot in Saudi Arabia gives them a better chance of keeping or increasing market share and not being eased out.
3. The foreign companies located in Saudi Arabia with Saudi partner will have easier access to the whole GCC market and its competitor companies which does not have local participation may find tariff barriers put up against its exports throughout the GCC area.
4. If a foreign company is located in Saudi Arabia with a Saudi partner and looking to the GCC as its market, it will be able to pick up inter GCC incentives.
5. The market in Saudi Arabia is still profitable, despite the recession and lowered purchasing

power. Saudi Arabia still a very large market in terms of spending power.

6. One of the biggest pluses is being on the spot to ensure that the foreign company is able to develop business, not to miss opportunities, not to lose existing business and to know the new regulations as they come in.
7. A foreign company on the spot can promote its interests before other competitors have heard of the opportunities. Companies on the spot too are better positioned to take advantage of the anticipated upturn in business due toward the middle of the 1990s.

CHAPTER 6

PROJECT EVALUATION

6.1 INTRODUCTION

The term project evaluation is a branch of applied welfare economics concerned with the issue: how should a national planner choose among alternative investment projects? It is part of the field of "Social Cost-Benefit Analysis", which addresses the problem of evaluating varieties of government activities, not just investment, with a view to choosing among them. Even though the role of social cost-benefit analysis is not restricted to government use, the theory provides a conceptual framework within which any individual as a citizen and social observer, can evaluate government action. Any concerned individual performs cost-benefit analysis continually.

The establishment of a feasible project is an important, if not the prime element, of a country's development process. Therefore, project evaluation occupies an important place in cost-benefit analysis and the development literature. Project evaluation which considers technical, economic and financial soundness, involves a comprehensive survey of the expected positive and negative effects of the proposed projects. The project is accepted only if its positive effects exceed its negative effects.

Otherwise, it is rejected. However, assessment of project benefits and cost is partly a matter of judgement and such judgement differs depending on the evaluation criterion and whether the project is analyzed from the private or national point of view. For a private commercial entrepreneur choice among alternative investment projects is simple if he knows his own objectives, which would be a reasonable assumption. All he has to do is to choose the project that satisfies his objectives best. For example he may be interested in commercial profit, in which case commercial profitability - adjusted possibly for risk - is his criterion of choice.

For a national planner the choice is more complex. In choosing investment projects his personal objectives are not important, but the most important is to satisfy the interest and the objective of the nation. This is complex, not merely because national objectives and interest are not easy to define, but also because the reading of these objectives by different planners may well vary.

There is another important reason why the problem is more complex for the national planner. The private commercial entrepreneur will have good information when the market prices are available. They enable him to estimate project profit. But not so for a national

planner. The national planner must have some understanding of how the project's impact is likely to affect national objectives. For him, market prices are often very soft data. He must have some understanding of the technological and information constraints underlying the economy in addition to the social and political constraints that impinge upon it.⁽¹⁾

Project evaluation has certain aspects that should be considered. King summarized them as: (1) technical, (2) managerial and administrative, (3) organisational, (4) commercial, (5) financial and (6) economic.⁽²⁾

Project evaluation is important, because a sound project can significantly contribute to the national economy, especially in developing countries. The governments in developing countries rely heavily on projects to achieve development objectives because of the difficulty in promoting development through other means. In Saudi Arabia and other OPEC countries the situation is different from other LDCs. Saudi Arabia

(1) The New Palgrave Dictionary of Economics, edited by John Eatwell, M. Milgate and P. Newman, 1987, p.1025

(2) John A. King, Economic Development Projects and Their Appraisal, (Baltimore: The Johns Hopkins University Press, 1967), pp. 3-14.

initiated projects as a part of their development programmes, primarily to reduce dependence on exporting crude oil. They must look to projects as a means for increasing total output over the long run, rather than simply to diversify and thereby stabilize the economy.

6.2 The Decision Rule for Undertaking a Project

When a project is undertaken, it causes a reallocation of resources in the economy, because the project draws inputs from the rest of the economy to produce output. Also, there will be a rearrangement of demands and supplies in other markets through the interconnection of the general equilibrium system. The project evaluator has to obtain an aggregate measure that indicates by how much society is better off or worse off with this project. This aggregate measure is obtained by evaluating the direct and indirect effect of the project in terms of a numeraire:-

1. The direct and indirect effects are evaluated in each period at current prices. The direct resource allocation effects on inputs used in the project are evaluated at their social opportunity cost, which is the true cost to society incurred by drawing the resources from alternative uses. Also the value of outputs is the benefit to society from having the additional outputs. The

value of the indirect effects is the welfare change to society arising from the resource reallocations induced elsewhere by the project.

These evaluations are carried out for every relevant time period and yield net benefits (NB_t) in current values for each period of time $t = 0 \dots, T$, where T is the last period that the project affects benefits and costs.

2. The net benefits must be aggregated in a common unit. This can be done by expressing all the values in the units of a common numeraire. The numeraire can be the consumption in the present or at any period of time. The conversion of future consumption values to present consumption values can be done using the discount rate at which society is willing to transform present into future consumption. The aggregation of current values to present values using the social discount rate yields the net present value of the project (NPV). Algebraically:-

$$NPV = \sum_{t=0}^T \frac{NB_t}{(1 + r)^t}$$

NB = Net benefit

r = social discount rate.

The NPV sign shows whether or not the society would be better off with this project. Also, it indicates by how much society is better off in

terms of present consumption. If there is more than one project, the one with the highest NPV should be undertaken to maximize social welfare.

The discount rate that makes the NPV equal to Zero is the internal rate of return. It is given by the value of λ that satisfies the following equation:

$$\sum_{t=0}^T \frac{NB_t}{(1+\lambda)^t} = 0$$

λ = internal rate of return

If $\lambda > r$ the project should be undertaken, whereas if there is more than one project the one with the highest λ should be chosen.⁽¹⁾

6.3 Evaluating the Net Benefits of a Project

The equilibrium allocation of resources will change when a project is introduced into the economy. So we need to evaluate the costs and benefits of that change. The welfare change can be written:

$$dW = \sum (p_i - t_i) dz_i + \sum t_i dX_i$$

X_i = is the consumption of commodity i

z_i = is the project production

p_i = is the consumer price of X_i

t_i = is the tax of good i

t_i can be negative in the case of subsidy.

(1) R. W. Boadway and N. Bruce, Welfare Economics, 1984, pp. 294-295.

The project quantities dz_i for the output supplied will be positive and negative for inputs demanded, and this will be the case if we implicitly assume that all inputs and outputs are traded and have market prices. If not, then $p_i - t_i$ could be the shadow cost of the good to society.

The project generally operates directly in only a small number of the many markets in the economy. For all others $dz_i = 0$ we need to differentiate between those markets that the project affects directly and those that it affects indirectly. If we use subscript i to index those markets affected directly and subscript j for those markets affected indirectly, then the welfare change becomes :-

$$dW = \sum (p_i - t_i) dz_i + \sum t_i dX_i + \sum_{j \neq i} t_j dX_j$$

The first two terms on the right hand side represent the direct effects of the project and it operates and form the basis for shadow pricing rules. The last term is the indirect effects.

If there is no distortion in the economy the welfare change expression would be:

$$dW = \sum p_i dz_i,$$

the welfare change of the project is evaluated by using the market prices p_i as shadow prices. So

private profitability would coincide with social profitability, but with distortion in the economy that is not the case.

6.4 Shadow Pricing of Purchases on Distorted Markets

If the input Z_k is traded in a distorted market, the shadow price of Z_k corresponds to the shadow pricing rule advocated by Harberger (1972).

$$\frac{\partial W}{\partial Z_k} = P_k - t_k + t_k \frac{\partial X_k}{\partial Z_k} + \sum_{j=k}^J t_j \frac{\partial X_j}{\partial Z_k}$$

The first three terms on the right hand side constitute the direct effect of the change in input Z_k and will be the shadow price of Z_k , and the last term is the indirect effect in other markets.

Denoting the shadow price of Z_k by S_k , then:-

$$S_k = p_k - t_k + t_k \partial X_k / \partial Z_k$$

If we take a partial equilibrium point of view, then the demand for X_k depends primarily upon its own price p_k . Similarly, the non-project supply y_k depends upon the supply price p_k and t_k . Then the market equilibrium for commodity k is given by:-

$$X_k (P_k) = y_k (P_k - t_k) + Z_k$$

Differentiating with respect to Z_k and holding the t_k constant

$$\frac{\partial P_k}{\partial Z_k} = \frac{1}{X'_k - y'_k}$$

X'_k and y'_k are the price derivatives of demand and supply.

$$S_k = P_k - t_k + t_k \frac{X'_k}{(y'_k - X'_k)}$$

$$= \frac{(P_k - t_k) y'_k - P_k X'_k}{y'_k - X'_k}$$

The last equation is known as Harberger's (1969) weighted average shadow pricing formula. The equation shows that the shadow price S_k as weighted average of the supply price $(P_k - t_k)$ and the demand price P_k , where the weights are the proportions in which a change in net output of k by the project results in a reduced supply on the one hand and an increase in the demand on the other. If k is an input, the proportion in which the project use comes from the increased supply in the market on the one hand and a reduced demand on the other.

If the elasticity of demand is denoted by :

$$\eta_k (= X'_k P / X)$$

and the elasticity of supply by :

$$\epsilon (= y (P - t) / y).$$

Then the Harberger's weighted shadow pricing formula may be written in the following way:-

$$S_k = \frac{\epsilon_k - \eta_k}{\epsilon_k / (P_k - t_k) - \eta_k / P_k}$$

This means that if the supplies are perfectly elastic ($\epsilon_k \rightarrow \infty$) or demands are completely inelastic ($\eta_k = 0$), the shadow price will be the supply price

$P_k - t_k$. If the demands are perfectly elastic ($\eta_k \rightarrow \infty$) or the supplies are completely inelastic ($\epsilon = 0$), the shadow price will be the demand price P_k .

Geometrically the intuition behind this shadow pricing rule can be illustrated in terms of the supply and demand diagram as in Figure 6.1. Z_k is an input purchased by the project. The supply and demand diagrams show the market for X_k with an initial equilibrium with consumer price p_k^0 and demand X_k^0 . If the project uses ΔZ_k of the input the demand curve will shift to the right, there will be a new equilibrium price p_k with non project demand of X_k^e and a supply of Y_k^0 . The area $X_k^e a b X_k^0$, the shaded area under the demand curve is the opportunity cost of the forgone demand. The area $X_k^0 c d Y_k^e$, the shaded area under the supply curve is the cost of the additional supply. The total of these opportunity costs can be approximated by:

$$X_k^e a b X_k^0 + X_k^0 c d Y_k^e \approx -P_k \Delta X_k + (P_k - t_k) \Delta Y_k$$

The opportunity cost per unit of input (the shadow price) is:

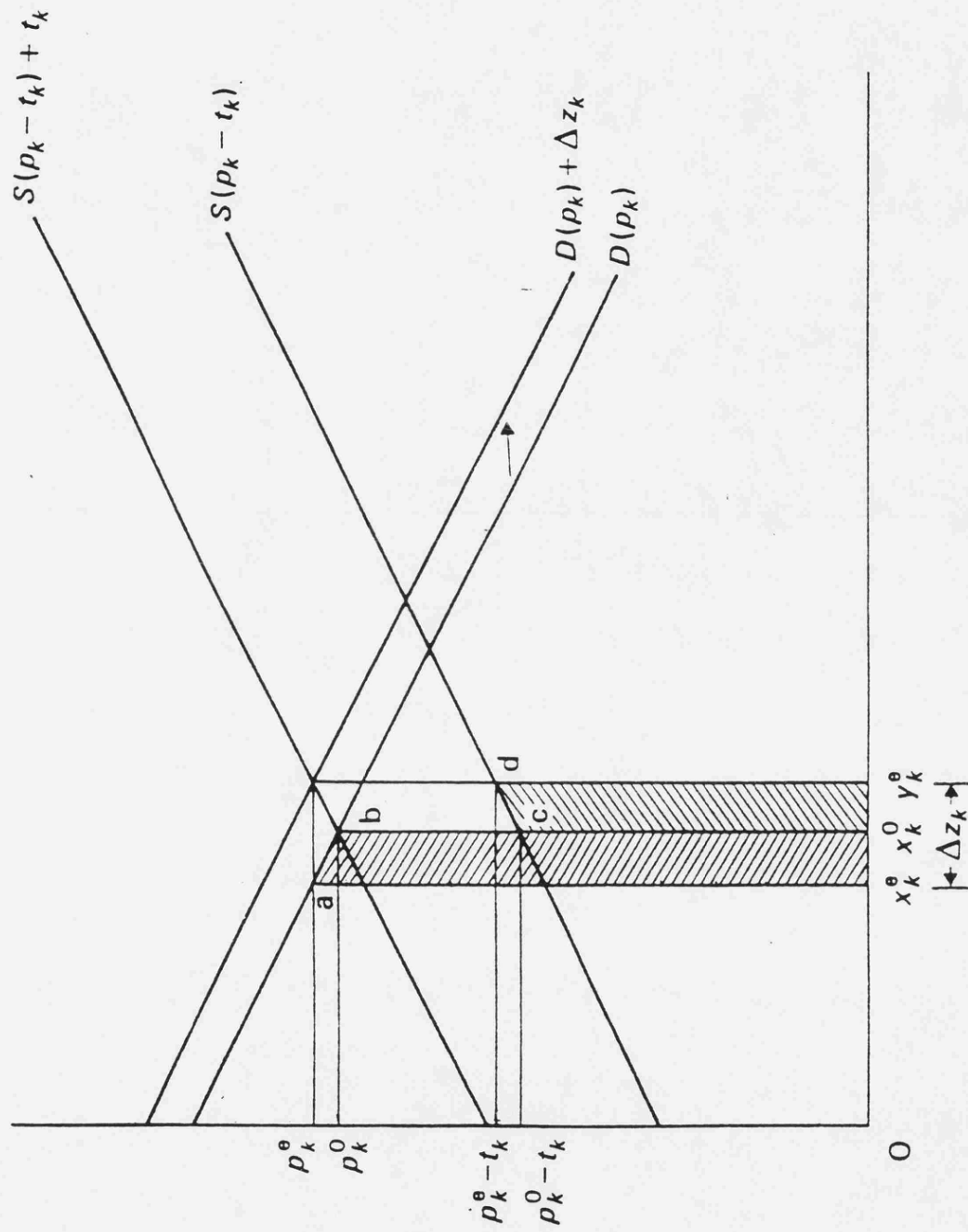
$$S_k = (P_k - t_k) \Delta Y_k / \Delta Z_k - P_k \Delta X_k / \Delta Z_k.$$

This is the Harberger weighted average formula.⁽¹⁾

(1) Ibid, pp. 297 - 300

FIGURE 6.1

SHADOW PRICING OF PURCHASES ON DISTORTED MARKETS



6.5 Factors Important for Analyzing Projects in Saudi Arabia

Saudi Arabia suffers from lack of technological expertise and managerial, skilled labour, and infrastructure. Like many other developing countries, Saudi Arabia suffers a dearth of not only technological expertise but also management capabilities required for undertaking the country's desired industrial investment. Moreover, skilled and unskilled labour within the country are extremely limited. The proportion of professional, technical, managerial and administrative labours declined from 14.6 percent of the total labour force in 1980 to 12.7 percent in 1985. But the proportion of unskilled labour increased from 30.0 percent to 31.7 percent over the same period as (Table 6.1) shows. On the other hand the demand for labour of higher skill increased in the period from 1985 - 1990, the proportion of professional, technical, administrative and skilled labours increased, while that of unskilled workers declined as (Table 6.2) shows. Additional manpower requirements by occupation group can be met by Saudis entering the labour market, and non-Saudis can be replaced (Table 6.3) show the additional new entering the labour force.

Saudi Arabia has turned towards importing foreign labours to satisfy its manpower needs. The total

TABLE 6.1

Estimated Employment by Occupation Group
In 1979/1980 and 1984/1985

Occupation Group*	1979/1980		1984/1985		1979/1980		1984/1985	
	Employment ('000)	Distribution (Percent)	Employment ('000)	Distribution (Percent)	Increase ('000)	Distribution (Percent)	Increase ('000)	Distribution (Percent)
Professional Technical Administrative and Managerial Workers	444.5	14.6	563.9	12.7	119.4			8.4
Office workers	687.5	22.8	1,020.2	23.0	332.7			23.4
Manual Workers (Skilled/Semi Skilled)	985.7	32.6	1,451.8	32.6	466.1			32.8
Unskilled Workers	908.3	30.0	1,410.1	31.7	501.8			35.4
TOTAL	3,026.0	100.0	4,446.0	100.0	1,420.0			100.0

* Professional and technical: persons holding a university degree or diploma from a higher institute after secondary school. Administrative and managerial: includes those persons to whom key responsibilities are given to operate and manage projects, and high officials in ministries and government departments.

Office workers: includes those with elementary certificate and training or experience from 1-3 years on the job.

Skilled workers: includes persons having training or job experience, such as machinists, trademen (eg. carpenters), tractor drivers, operators of heavy equipment etc.

Source: Saudi Arabia Ministry of planning Fourth Development plan 1985-1990, p.35.

Table 6.2

**ESTIMATED EMPLOYMENT BY OCCUPATION GROUP
IN 1984/85 AND IN 1989/90**

Occupational Group	1984/85		1989/90		Employment Change 1984/85 to 1989/90
	Employment (Thousand)	(Percent)	Employment (Thousand)	(Percent)	
Professional Technical Administrative and Managerial Workers	563.9	12.7	558.6	13.2	-0.9
Office Workers	1,020.2	23.0	1,001.6	23.7	-1.8
Manual Workers (skilled/semi-skilled)	1,451.8	32.6	1,445.5	34.3	-0.4
Unskilled Workers	1,410.1	31.7	1,214.8	28.8	-13.9
TOTAL (all civilian sectors)	4,446.0	100.0	4,220.5	100.0	-5.1

TOTAL SAUDI WORKING-AGE POPULATION AND CIVILIAN WORKING FORCE 1984/85 AND 1989/90

	1984/85			1989/90		
	Males	Females	Total	Males	Females	Total
Working-Age Population (000)	2,686.0	2,659.0	5,345.0	3,237.0	3,210.0	6,447.0
Labour Force						
Participation Rate (Percent)	61.4	5.1	33.4	61.3	5.5	33.5
Labour Force (000)	1,649.2	136.8	1,786.0	1,984.1	176.6	2,160.7

Source: Saudi Arabia Ministry of Planning Fourth Development plan 1985-1990, p.89.

(Table 6.3)

ADDITIONAL MANPOWER REQUIREMENTS BY OCCUPATION AND PROJECTED
SAUDI NEW ENTRANTS TO THE LABOUR FORCE BY LEVEL OF
EDUCATION (1984/85-1989/90)

PROJECTED TOTAL JOB OPENING:		PROJECTED TOTAL SAUDI NEW ENTRANTS TO			REPATRIATION OF	
1984/85-1989/90		THE LABOUR FORCE			NON-SAUDI WORKERS	
Occupational Group	Total Job Openings	Highest Level of Educational Attainment	Males	Females	Total	
	(000)		(000)	(000)	(000)	(000)
Professional, Technical, Administrative and Managerial Workers	4.3	University and College Graduates	40.7	14.1	54.8	
Sub-total	4.3	Sub-total	40.7	14.1	54.8	50.5
Office Workers	6.5	Incomplete Post-Secondary Education	34.4	4.6	39.0	
Manual Workers (skilled/semi skilled)	26.3	Secondary and Intermediate School Graduates	20.1	7.9	28.0	
		Technical and Vocational Training programs	100.2	1.0	101.2	
		Incomplete Secondary or Intermediate Education	87.7	12.0	99.7	
Sub-total	32.8	Sub-total	242.4	25.5	267.9	235.1

Table 6.3 cont/2...

PROJECTED TOTAL JOB OPENING: 1984/85-1989/90		PROJECTED TOTAL SAUDI NEW ENTRANTS TO THE LABOUR FORCE		REPATRIATION OF NON-SAUDI WORKERS	
Occupational Group	Total Job Openings	Highest Level of Educational Attainment	Males	Females	Total
(000)		(000)	(000)	(000)	(000)
Unskilled workers	-143.1	Elementary School Graduate and Dropouts	42.0	2.0	44.0
		New entrants from the households	120.1	7.4	127.5
Sub-total	-143.1	Sub-total	162.1	9.4	171.5
					314.6
Total	-106.0	Total	445.2	49.0	494.2
					600.2

SOURCE: Saudi Arabia Ministry of Planning Fourth Development plan 1985-1990, p.91

employment grew by 1,420,000 in the period 1980-85, the Saudi accounted for 292,800, approximately 21 percent. The Saudi labour force grew at an average annual rate of 3.7 percent, and the non-Saudi growth rate 11.7 percent (see Table 6.4). The number of Saudi females in the labour force increased at an average annual rate of 1.5 percent. The share of Saudis in the labour force declined from 49.4 percent in 1980 to 40.2 percent in 1985, but it is expected to increase to 51.2 percent in 1990, and the share of non-Saudis in the labour force will decline from 59.8 percent in 1985 to 48.8 percent in 1990, as (Table 6.5) shows.

Another factor is the small domestic market in Saudi Arabia, which requires that industrial projects be export-oriented.

The manpower, technological, and physical constraints to development give Saudi Arabia an absorptive capacity problem. The managerial and technical constraints can be solved by transferring technology. Technological transfer is necessary due to the length of time required to establish a technological base in a country lacking sophisticated research and development activities, which are the main foundation for technological advancement.

NATIONALITY COMPOSITION OF THE CIVILIAN LABOUR FORCE

	Labour Force	Labour Force Growth		
	1979/1980	1984/85	Increase	Average Annual Rate
	(Thousand)	(Thousand)	(Thousand)	(Percent)
Saudi Men	1,366.4	1,649.2	282.8	3.8
Saudi Women	126.8	136.8	10.0	1.5
Sub-total: Saudi	1,493.2	1,786.0	292.8	3.7
Sub-total: Non Saudi	1,532.8	2,660.0	1,127.2	11.7
TOTAL	3,026.0	4,446.0	1,420.0	8.0

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TABLE 6.5

PROJECTED CIVILIAN EMPLOYMENT BY NATIONALITY

(1984/85 to 1989/90)

<i>Nationality/Sex</i>	<i>Civilian Employment 1984/85</i>	<i>Net Change 1989/90</i>	<i>Annual Growth Rate 1984/85 to 1989/90</i>
	(Thousand)		(Percent)
Saudi Men	1,649.2	1,984.1	334.9 3.8
Saudi Women	136.8	176.6	39.8 5.2
Sub total: Saudis	1,786.0	2,160.7	374.7 3.9
Non-Saudis	2,660.0	2,059.8	-600.2 -5.0
TOTAL	4,446.0	4,220.5	-225.5 -1.0 [†]

* The one percent annual decline in civilian employment relates to the economy as a whole.

Source: Saudi Arabia Ministry of Planning Fourth Development plan 1985-1990, p.84.

6.6 Current Methods of Project Evaluation

Several project evaluation methods have been developed because of the growing interest in development planning during the second half of the twentieth century. These methods employ different project evaluation techniques with different degrees of complexity. In this section different evaluation approaches will be surveyed, and characterised as those undertaken from the private and national points of view, as embodying complex methods, and as concerned with issues related to nonrenewable resources.

6.6.1 Private and National Perspective Evaluation Approaches

For analysing the project from the private and national points of view several evaluation methods have been developed. These methods are relatively simple in their application. In this section some of these approaches are summarised.

6.6.1.1 Capital Budgeting

Capital availability plays an important role when undertaking a project or group of projects that prove to be viable. Insufficient capital could preclude implementation of these projects. This situation often

leads to capital rationing. Bussey⁽¹⁾ states that restricted funds for investment occur because of limitations imposed either by management (internal) or the capital market (external). He adds that internal rationing occurs when management decides to limit the funds available for capital expenditure to a fixed amount in a given period. External rationing takes place when the firm cannot obtain funds from the capital market in sufficient amounts at prices considered to be economical.

The problem of capital rationing has been investigated by Lorie and Savage - when discussing the task of rationing capital among competing investment opportunities, they devised a technique to deal with this problem by employing multipliers and associating them with investment costs.⁽²⁾ Using this technique decreases the attractiveness of an alternative in proportion to its use of the scarce capital. This criterion is expressed as $NPW - P$ (PW of cost), where P is a multiplier computed by trial and error.⁽³⁾

(1) Lynn E Bussey, The Economic Analysis of Industrial Projects, (Englewood Cliffs, N.J.: Prentice Hall, Inc. (1978), p. 246 - 247.

(2) James H. Lorie and Leonard J. Savage, "Three Problems in Rationing Capital", Journal of Business, October 1955 pp.229-39.

(3) Newman, p.407.

Capital budgeting addresses situations that may lead to ranking inconsistencies when different reinvestment possibilities are applied to alternatives with different lives. Solomon⁽¹⁾ proved that these inconsistencies disappear if a common reinvestment rate is assumed. While Solomon's assumption is applicable in some cases, in other cases reinvestment rates may differ according to the types of projects and investors. The more complex approaches, to be discussed later, address cases are not covered by the Solomon assumption.

6.6.1.2 The World Bank Approach

Since the end of World War II, development planning has evolved tremendously as an approach for achieving national objectives. Governments of developing countries rely on development projects to help in achieving their goals as an alternative to fiscal and monetary measures. Shaner⁽²⁾ cites another function of projects: that is, they are a means for transferring loan and grant funds from developed countries to developing countries, sometimes through international organisations.

The World Bank has emerged as a leading organisation in providing loans for various development projects in

(1) Ezra Solomon, "The Arithmetic Capital-Budgeting Decision", Journal of Business, April 1956.

(2) Shaner, p.25.

developing countries. This task has necessitated the formulation of evaluation procedures to study project viability before loans are granted. The concept of cost-benefit analysis was adopted to serve this purpose. Halmer⁽¹⁾ of the World Bank's Economic Development Institute pointed out that benefit-cost analysis considers only those variables that are relevant to the project under consideration.

Helmerts further explained this theory by saying:

"As long as resources with low valued uses can be transferred to a project where they have higher valued uses, then the project should be acceptable... this is what the theory of benefit-cost analysis is all about."⁽²⁾

This concept was reiterated by Gittinger⁽³⁾ another World Bank official, when he described agricultural project as the whole complex of activities involved in using resources to gain benefits.

The World Bank approach is to evaluate the project from the national or social rather than the private point of view. This approach is called economic analysis, as explained by Gittinger⁽⁴⁾:

(1) F. Leslie, C. H. Helmers, Lecture Notes on Project planning papers published by the Industry and Banking Division of the Economic Development Institute, The World Bank (undated), p.70.

(2) Idid., p.106

(3) Gittinger, p.1

(4) Gittinger, p.5

For any project, we are interested.... in the total return or productivity or profitability to the whole society or economy of all resources committed to the project regardless of who in the society contributes them and regardless of who in the society receives the benefits.

Nevertheless, financial analysis is also used to evaluate the viability of the project from the private perspective. Shaner⁽¹⁾ states that economic and financial analysis should be conducted separately in order to prevent confusion arising from the fact that items used in the calculation of the two types are often similar. For example, taxes in the economic analysis are treated as benefits, and subsidies as costs, whereas in the financial analysis, taxes are treated as costs, and subsidies as a return.⁽²⁾

Economic analysis helps the analyst to identify the degree of the project's contribution to overall national economic growth in the context of a comprehensive national development plan. In this respect, shadow prices of the factors of production are used in cash-flow calculation. A shadow price is one that comes closer to measuring a factor's real value to society than does its market price⁽³⁾.

(1) Shaner, p.38
(2) Gittinger, p.8
(3) Shaner, p.91

Shadow prices are incorporated into the analysis through adjustment factors applied to both inputs and outputs. Especially important are the factors of production such as abundant unskilled labour and scarce domestic capital and foreign exchange. In the adjustment process, the shadow price is estimated and substituted for the market values. The economic analysis is conducted using the previously mentioned decision criteria algorithms.

In Saudi Arabia the situation of abundant manpower and scarce foreign exchange does not exist due to the small population and the availability of foreign exchange from oil revenues. As a result, these shadow prices adjustments have less significant. That is, the shadow price of Foreign exchange will equal its free market exchange rate. Surplus labour does not exist, so market wages will also prevail. The shadow price of capital - abundant countries is lower than that in countries where capital is scarce, so discount rate may be set by the international market.

6.6.2 Complex Approaches

There are other approaches in addition to those previously mentioned. Other efforts are employed to establish a methodology for project evaluation which

considers the intricate complexities confronting investment decisions in LDCs. The two most famous studies are one commissioned in 1968 by the Organisation for Economic Cooperation and Development (OECD), referred to as Little and Mirrlees, and another commissioned in 1972 by the United Nations Industrial Development Organisation (UNIDO), referred to as Dasgupta, Marglin, and Sen.⁽¹⁾ This section briefly views these two approaches.

6.6.2.1 The UNIDO Guidelines

The fundamental concept of the UNIDO approach is the use of aggregate consumption as the numeraire to measure the benefits and costs of the project under study. The aggregate consumption of the project can be determined by measuring the consumers willingness to pay for the output of the project. The costs can be measured by the maximum benefits foregone as a result of using the resources and services for the project. These benefits foregone may be those from current consumption, or from future consumption had the resources been used to finance other investment. When future benefits are reinvested rather than consumed, the profitability (in terms of future

(1) These studies are (a) Manual of Industrial project Analysis in Developing Countries, Vol. II: Social Cost-Benefit Analysis (Paris: OECD, 1969); (b) Guidelines for Project Evaluation (New York: UNIDO, 1972).

consumption) depends on the nature of the reinvestment⁽¹⁾. Because of the assumed capital constraint, projects that lead to greater investment in the future are assumed to generate more benefits than those projects that lead to greater near-term consumption. Similarly, projects that draw their resources from other investment are assumed to cost more in terms of aggregate consumption than those projects that divert resources directly from consumption.⁽²⁾

The guidelines realize that the market prices of goods and services are inadequate to conduct the cost and benefit analysis because they do not reflect the values of cost and benefit from the national perspective. Shadow prices are introduced to the methodology and employed to reflect the prices real value to society. These are referred to as "national parameters" and are provided by the central planners, e.g. shadow prices of the foreign exchange, investment, and unskilled labour.⁽³⁾ The UNIDO method uses the discount rate at which decision makers believe that consumers are indifferent between present and future consumption. This discount rate is called the social rate of discount and would be provided

(1) UNIDO Guidelines, p.184.

(2) Shaner, p.124

(3) Paratha Dasgupta, "A Comparative Analysis of the UNIDO Guidelines and the OECD Manual, "Bulletin, Oxford University Institute of Economics and Statistics, Vol.34 (February 1972), p.36.

by the central planners as a national parameter.⁽¹⁾

Estimation of these parameters is intricate and cumbersome. Discussing the UNIDO and OECD methods, Yotopolos and Nugent stated⁽²⁾

Calculation of these shadow prices is complicated by the fact that they do not depend entirely on objective phenomena that can be foreseen easily by the central planners.... these values cannot be estimated with any degree of precision, but rather must be guessed.....

The UNIDO guidelines impose the prediction of government policies on the project evaluations. This responsibility requires skills of political science rather than economics which requires more professionals to be added to the project evaluation team ⁽³⁾. This situation could add new burdens to LDCs since they rely heavily for their project evaluation on foreign experts unfamiliar with domestic political paths.

Waterston⁽⁴⁾ pointed out that the UNIDO methodology

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- (1) UNIDO Guidelines, p.29.
 - (2) Pan A. Yotopoulos and Jeffrey B. Nugent, Economics of Development, (New York: Harper and Row, 1976), p.384.
 - (3) Pan A. Yotopoulos and Jeffrey B. Nugent, Economics of Development (New York: Harper and Row, 1976), p.390.
 - (4) Comments by Albert Waterston, Proceedings of the Symposium of the Use of Socioeconomic Investment Criteria in Project Evaluation, Inter-American Development Bank, 28-30 March 1973, p.168.

required strong central planning organisation. He then asked how many developing countries could possibly accomplish this. This comment reveals the difficulties involved with implementation of the methodology proposed by the guidelines authors. Paul Isenman attributes this problem to the gap that exists between theoreticians and practitioners.⁽¹⁾ However, even the UNIDO Guidelines have merged the concepts of savings and investment into the project evaluation technique through cost benefit analysis. This effort is overshadowed by the complexity of the approach and its application because data required to implement this methodology are often scarce, in addition to the organisational difficulties just explained.

6.6.2.2 The OECD Manual

The Little-Mirrlees proposals are basically new only in the valuation system they propose to reach the shadow or accounting prices to be employed in the economic analysis. Once the appropriate accounting prices have been determined, the methodology they recommend to compare projects and decide whether they are worthwhile implementing is the same as that discussed in connection

(1) Comments by Paul Isenman, Proceedings of the Symposium on the use of Socioeconomic Investment Criteria....., p.173.

with the World Bank method⁽¹⁾. As in the UNIDO Guidelines, the OECD Manual perceives market prices to be unreliable in the project evaluation analysis. However, as Yotopoulos pointed out, unlike the UNIDO approach, only the shadow prices of capital and unskilled labour are used in the analysis; the OECD does not formally introduce a shadow price of investment, since investment in terms of foreign exchange is the numeraire of the method.⁽²⁾

The Manual differentiated between two types of goods; (1) traded goods and services that can actually be exported, for which world prices are appropriate, and (2) non traded goods and services that are too costly to be produced elsewhere and imported such as electric power and construction for which world prices are not appropriate. The manual suggested marginal social costs are appropriate estimates of shadow prices.⁽³⁾

The OECD Manual emphasises the importance of cooperation between project evaluators and project managers. The manual has been criticised for its

(1) Gittinger, p.44

(2) Yotopoulos and Nugent, p. 389.

(3) Dasgupta, pp. 39-40

complexity and inapplicability. Isenman stated, "The method of the Manual is very complicated to be applied at any stage...."⁽¹⁾ Gittinger further explained this case:⁽²⁾

"Comments about the system have centered around its complexity and whether, in fact, it leads to better investment decisions.... Their system of determining accounting prices is difficult both to understand and to apply. Even highly trained economists admit to ambiguities in the system as Little and Mirrlees expound it and question its practical applicability. To suggest that it could be used broadly within a government appears to presuppose a supply of highly trained manpower able to devote its time to determining accounting prices which is questionable in any developing country".

Tests have been conducted to determine if the OECD approach could result in more effective results than the ones already in use; however, doubts arose about the results of these investigations. Gittinger summarised these efforts, saying:⁽³⁾

Few tests have been made to determine whether the Little and Mirrlees methodology would lead to a significantly different investment pattern from the valuation methodology for economic analysis... tests by the World Bank staff have led to the conclusion that there would be very few, if any, changes in investment decisions where the Little and Mirrlees system adopted.

This approach might be inapplicable to OPEC countries due to the region's unique social and economic environments.

(1) Isenman, p.137
(2) Gittinger, p.45
(3) Gittinger, p.46.

6.7 Non-Renewable Resources

Natural resources have been defined as any commodity provided by nature and not produced or producible by man. Where the supply of this resource is fixed and cannot be augmented, it is called an exhaustible or non-renewable natural resource.⁽¹⁾ Oil, like natural gas, coal, copper, ore and other minerals, is an exhaustible resource available in a finite amount. If more oil or gas is consumed today then less will be available for consumption in the future. In contrast with renewable resource like air, water, or timber, current consumption does not affect future availability, since these resources will regenerate in the future. The exhaustibility of the extractive resources has become a major topic in resource economic literature.

In dealing with exhaustible resources, the obligation to future generations has been a major concern to economists as well as conservationists. Barnett and Morse proposed their conservation strategy, saying:⁽²⁾

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- (1) J. E. Stiglitz, "A Neoclassical Analysis of the Economics of Natural Resources; in V. Kerry Smith (ed), Scarcity and Growth Reconsidered (Baltimore: The Johns Hopkins University Press 1979), p.36.
 - (2) Harold J. Barnett and Chandler Morse, Scarcity and Growth: The Economics of Natural Resource Availability (Baltimore: The Johns Hopkins University Press, 1963), p.247.

".....nonrenewable resources should be used only after renewable resources were fully employed. Water power before coal, for example, physical "waste" should be reduced wherever it was found; current production should be constrained, if need be, to retard the depletion of nonrenewable resources".

Pigou⁽¹⁾ pointed out that the welfare of future generations should be taken into account through considering a low discount rate, lower than the marginal productivity of capital. Fisher and Krutilla disputed Pigou's argument, stating:⁽²⁾

.....attempts to tinker with an otherwise appropriate social discount rate for the purpose of conserving natural resources are at best arbitrary and are in fact likely to result in more rapid exploitation of at least some of these resources.... a lower discount rate was vague, however, in that it is not clear whether the lower rate was to apply solely to some particular projects in the public sector, to all such projects, or even to all the investment opportunities in an economy. If either of the former, it leads to inefficiency and can be justified only on second best grounds. If the latter, it is likely to have an effect on the rate of extraction of exhaustible resources just the opposite of that intended".

Scott has argued that reduction in the discount rate would tend to result in more, not less, rapid depletion

(1) A. C. Pigou, The Economics of Welfare (London: Macmillan, 1933), pp. 24-27

(2) Anthony C. Fisher and John V. Krutilla, "Resource Conservation, Environment Preservation and Rate of Discount" Quarterly Journal of Economics, Vol. 89 (1975), p.359.

of natural resources:⁽¹⁾

"....Natural products which are necessary for those capital industries which it is profitable to extend in scale will be in great demand, and it may happen that the increased investment in capital goods is impossible without the rapid depletion of some natural resources".

Barnett and Morse commented⁽²⁾

".....the process of discounting is one of determining the value of future income relative to present income, to the present generation. It is keyed to the welfare of those now living, not to that of future generations. If it were desired that the welfare of future generations be taken into account, it should be done by attempting to determine the value to them of alternative prospective incomes, not juggling the interest rate might or might not be appropriate".

Professor Lewis stated that even though resource exploitation plays a major role in economic growth, its success in doing so will depend on other factors:⁽³⁾

"The extent of a country's resources is quite obviously a limit on the amount and type of development which it can undergo. It is not the only limit, or even the primary limit. For most countries could make better use of their existing resources than they do. Given the country's resources, its rate of growth is determined by human behaviour and human institutions; by such things as energy of mind, the attitude toward material things, willingness to save and invest productively, or the freedom and flexibility of institutions".

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- (1) Anthony Scott, Natural Resource: The Economics Conservation, (Toronto: University of Toronto Press, 1955), p.95
(2) Barnett and Morse, pp. 248-249.
(3) W. Arthur Lewis, The Theory of Economic Growth (Homewood; III Richard D. Irwin, Inc. 1955) p.52

Therefore, future welfare can be ensured not only through conservation of natural resources, but more importantly, through laying the groundwork for sustainable growth that will continue after these resources are exhausted. This ultimate goal can be achieved through optimal utilization of nonrenewable resources and extension of their productive lifespan to derive the maximum utility along the maximum time duration and reinvesting their revenue into several productive sectors in the economy. Technology plays a key role in this regard.

Emphasising the role of technology, Robinson stated that mineral reserves are not geologically fixed quantities; rather, they are affected by prices, technology, discoveries, and the location of markets.⁽¹⁾

Peterson and Fisher⁽²⁾ emphasised the importance of technical advances in the extractive industry. They stated that technical changes have largely prevented the erosion of exhaustible reserves.

(1) Collin Robinson, "The Depletion of Energy Resources", in D. W. Pearce and J. Rose (eds)., The Economic of Natural Resource Depletion (New York: John Wiley and Sons, Inc. 1975) pp. 21-55.

(2) F. M. Peterson and A. C. Fisher, "The Exploitation of Extractive Resources: A Survey, "The Economic Journal", Vol. 87 (December 1977). p.711

Brown has expressed great optimism in the use of advanced technology to solve the energy depletion problem:⁽¹⁾

"The technologies for producing oil and gas from the many unconventional sources are now under active development..... hopefully, fast enough to provide a smooth transition away from conventional petroleum sources.... technological developments in the extraction of conventional oil and gas should make great progress. That progress might substantially increase current estimates of available supplies over the longer term, and help to stretch out and smooth out the long-term transition to other energy sources".

The rate of petroleum exploitation has been of general concern especially for some Gulf states. With a fixed and known stock of exhaustible resources in the nature of capital assets, the owner must select a depletion policy, particularly an appropriate rate of depletion. This necessity has led some oil-producing countries to accept downstream petro-industries as the centre piece of their development strategy. Unfortunately, this policy has its shortcomings, in that the country's oil and gas reserves must ultimately become depleted.

In his evaluation of some OPEC countries development

(1) William M. Brown, "Outlook for Future Petroleum Supplies", in J. L. Simon and H. Khan (eds). The Resourceful Earth: A Response to Global 2000 (New York: Basil Blackwell Inc. 1983), p.361.

programmes, El Mallakh stated:⁽¹⁾

".....when a single commodity such as oil plays so vital a role in the economy and when that commodity is a wasting asset, it is then crucial that not only the asset itself be exploited by a very sound and rational production utilization programming policy, but also the actual and potential proceeds from it must be utilised in a way that contributes most to the objective of achieving a stage of self-sustaining economic growth".

The dilemma of resource scarcity versus the goal of sustainable economic growth can be overcome through physical and social development programmes, as outlined earlier. Webb explained that the answer to the question of resource scarcity and human prosperity in the years to come lies with the technical breakthroughs. He added:⁽²⁾

"it is only by continually examining and re-examining these questions of the individuals relationships to the physical earth, and test the past, present, and the future use of resources it is possible to consider the future with any degree of informed hope".

But while waiting for such technical breakthroughs, a country heavily dependent on a depletable resource might well search for ways to base its growth on nondependable resources. Small countries and regions

(1) Ragaei El Mallakh, Economic Development and Regional Cooperation: Kuwait (Chicago: University of Chicago Press 1968), p.73.

(2) Kempton E. Webb, "Global Independence" in M. Glassner (ed.), Global Resource: Challenges of Interdependence (New York: Praeger, 1983), p.643.

such as Denmark, Switzerland and Hong Kong provide successful example.

6.8 Project Analysis Concepts For Saudi Arabia

National development plans usually aim toward two main integrated objectives: (1) to increase and diversify the national income, and (2) to correct inappropriate distribution of income. Combine, these two objectives lead to a higher and more equitable standard of living for a country's population.

Saudi Arabia industrial development program has been centred mainly on diversification of national income by using indigenous natural resources (oil and gas) more effectively through energy-based industrialisation. The hydrocarbon resources supported Saudi's industrial program as: (1) feedstock in refining, fertilising, petrochemical and gas liquidation industries, and (2) cement and steel industries, source of energy in water desalination, and power generation. Even though financial capital is not a constraint, Saudi Arabia faces manpower shortages, lack of technological expertise and managerial skills, skilled labour and unskilled labour. The proposed analysis concepts should consider these constraints and attempt to offset their effects on the economy. These concepts are designed to evaluate the

project by its contribution to the national income, its contribution to the people's welfare its contribution to relieving the economy's dependence on nonrenewable resources.

6.9 Project's Contribution to the National Income

The project's contribution to the national income can be based on its economic efficiency through estimation of its direct consequences and their net impact on national income. The direct consequences include costs of the initial investments, the operating and maintenance costs, and the direct benefits from the project, eg. receipts of the output sales. In the case of oil and gas projects, the direct costs include: (1) initial investment covering the exploration stage; (2) field development costs, eg., wells drilling, production facilities, construction, etc., (3) costs of operating and maintenance eg., reservoir pressure maintenance through recovery programs, equipment maintenance and replacement, etc. Benefits result from the sales of crude oil, natural gas or their processed products.

6.10 The Net Present Worth Criterion: A Measure of Efficiency in Resource Use

In measuring the effects of flow of costs and benefits to and from the project, which determines its economic efficiency and its degree of participation in

national productivity, the net present worth (NPW) decision criterion is used in this study. This decision criterion calls for accepting all projects whose NPW is positive and rejecting the ones with negative NPW.

The net present worth in any given year during the project life is expressed as:

$$NPW = \sum_{j=0}^n \frac{B_j - C_j}{(1 + i)^j}$$

where:

n = project life
j = the year during which costs and benefits occur
B_j = benefits in the jth year
C_j = costs in the jth year
i = interest rate.

The net present worth is a standard, straightforward measure of project efficiency. In Saudi Arabia case this seems to be appropriate on two counts. First, the dynamics of reinvestment which are handled through capital budgeting techniques of multiple combinations of projects of different time dimensions (eg. Lori and Savage article discussed earlier) or through the reinvestment formula of texts such as the UNIDO Guidelines not only seem overly complicated but unnecessary. The primary reason in support of the standard approach is simply that near term budget constraints and lack of control over subsequent

investments, which make capital budgeting and reinvestment important issues in capital budgeting for the conditions addressed in the UNIDO guidelines, are not a problem of Saudi Arabia. The second reason for concentrating on the NPW criterion is that the government of Saudi Arabia has considerable control over the country's resources, both their generation and distribution among the country's population.

NPW calculations will be based on deflated cash flows, which is common practice in project analysis. The major justification for relying on such an assumption about the cash flows is the extreme difficulty in projecting prices for the great quantity of project inputs and outputs over the project's life with any degree of predictive accuracy; moreover, while foreign trade exercises a large influence over Saudi Arabia economy, the general assumption of inflation influencing project benefits, costs, and the discount rate is a reasonable, if not precise, assumption; the implications of this approach are that the discount rate should also be deflated (ie., remove the effects of inflation from the interest rate).

Considering Saudi Arabia situation, where it is experiencing an absorptive capacity constraint resulting

in investment abroad, the government should probably consider an investment strategy similar to that of a wealthy individual who diversifies his portfolio among various investment in varying degrees of profitability and riskiness; in the Saudi's case, this concept would be extended to various securities and currencies of several countries. Of course, investing internationally does not provide jobs, train labour, or develop Saudi Arabia economy; rather, it provides the capital resources for future development; also, job provision is not a critical issue to Saudi Arabia, except as related to training, due to the country's manpower shortage.

6.11 Projects Contribution to the People's Welfare

The welfare objectives centre on absolute levels of consumption (of goods and services), relative levels of consumption among the current and future generation (ie. international welfare), and quality of life that is related to cultural and aesthetic values. If the later are taken largely as given, then welfare criteria center on absolute and relative consumption. The levels of absolute consumption in the aggregate sense are measured by the NPW; and concern over relative levels of consumption is reflected in the choice of the discount rate. This leaves relative consumption among the current population as the principal factor of concern for this

measure of project's contribution to Saudi Arabia national objectives.

The project planning become especially important to the LDCs, as compared with the more advanced economies, because of the LDCs, traditionally limited abilities to improve income distribution through taxes duties, subsidies and related welfare measures; consequently projects directed toward target groups and areas become an important means for income distribution; moreover, trade-offs must often be made between efficiency and welfare because projects are not superior on both counts. The issue of income distribution normally confronting LDCs does not present itself to Saudi Arabia, the reason is that the country's major income source is petroleum industry, which the state controls thus, the government has within its means the capability of raising the revenues necessary for benefiting those employed by this industry, which should account for a significant percent of the country's industrial workers; on the distributing side, the government would have strong wage - setting capabilities by controlling wages of those working in the petroleum industry; such control would strongly influence wages of supporting industries and the services; by maintaining wages at some target level and through ample benefit packages for education, health, retirements,

etc., the distributional problems would be minimized.

In Saudi Arabia's case the project's welfare characteristics are therefore, of only marginal value from the analytical point of view.

Since the government has access to both the revenues and the distributional means, that is, whatever net revenues are generated can be redistributed in accordance with the government's welfare objectives; in other words, because the government has these revenue and distributional means at its disposal, distribution of project benefits is independent of character of the investment itself; the major determinants of welfare are thus the size of the surplus, which is measured by the NPW, and the government's welfare policies, which are not project specific.

6.12 Measuring Welfare Change

There are two basic concepts in cost-benefit analysis they are the compensating variation (CV) and the equivalent variation (EV).

The CV is the maximum amount of money the house hold would be willing to give up in order to move to the new situation. If the household is better off in the new

situation than the old situation, CV is positive; but if worse off it is negative. For non-inferior good the CV exceeds the area under the Marshallian demand curve, but the Marshallian measure exceeds the EV.

The Equivalent Variation (EV) is the minimum amount of income the consumer would be willing to accept in order to forgo the move from the old situation to the new one.

$CV > 0$ is both necessary and sufficient for utility to increase. If M is the Marshallian measure then:

$CV \geq M \geq EV$	For noninferior good
$CV \leq M \leq EV$	For inferior good
$CV = M = EV$	When the good in question has zero income elasticity.

The economics consists of millions of consumers. Most of these consumers are affected by any change in the allocation of resources caused by the project undertaken. So we need to aggregate consumers into a single representative consumer.

6.12.1 Aggregate Welfare Measure

The aggregate CV or EV are the concepts used for

measuring the aggregate welfare change. The Kaldor compensation criterion suggests that to undertake a project if those who gains from the change can hypothetically compensate those who lose yet remain better off. The Hicks test is passed if the potential losers are unable to compensate the potential gainers and remain better off than they would be if the change occurs.

The Kaldor test is passed if: $\Sigma CV \geq 0$, it is both necessary and sufficient condition for a compensation test to be passed. Another measure is by using the social Welfare Function, if social welfare, W is differentiable function of individual utility U_i , then:

$$dW = \sum_i \frac{\partial W}{\partial U_i} dU_i$$

and if the individual utility is a function of his income Y_i ,

$$\begin{aligned} dW &= \sum_i \frac{\partial W}{\partial U_i} \frac{\partial U_i}{\partial Y_i} dY_i \\ &= \sum_i W_i dY_i \end{aligned}$$

W_i is the social weights $W_i = 1$ for all individuals. Economists use the equal weight form to argue for or against the projects⁽¹⁾.

(1) Ray Anandarup Cost-Benefit Analysis Issues and Methodologes, A World Bank Publication, 1986, p.23.

6.13 Projects Contribution to Relieving the Economy's Dependency on Nonrenewable Resources

The long-run strategy of Saudi Arabia, as explained earlier, should rest on gradual transfer from reliance on a non renewable resource base to one that is renewable. This includes the possibility of reviving the fishing industry, optimal use of the available arable land, acquisition of skills in commerce and banking, and development of an active service sector. Deriving an investment policy based on a shift to a renewable resource base is a complex subject that centres on reduced productivity from depleted resources (at some level of technology and prices), projections of technological improvements, optimal extraction rates, opportunities for extending a resource's life through greater energy inputs, intertemporal welfare and the implications for an appropriate discount rate. These comprise difficult issues and considerable uncertainty about the course of future events over which economists have debated for many years.⁽¹⁾

In the absence of off-setting improvements in Saudi Arabia resource base... ie., shifting from nonrenewable

(1) See, for example, Bruce Herrick and Charles P. Kindleberger, Economic Development (New York: McGraw-Hill, 1983).

to renewable the productivity of its investments would decline. But with its extensive reserves of oil and gas, appear to have adequate time before the reduction in its resource base seriously affects the profitability of its investments.

Delaying the urgency with which Saudi Arabia needs to find suitable renewable resource bases would be the possibility of a general resurgence in prices as the quantities of oil and gas become depleted. The extent to which these price increases would accrue to Saudi's benefit depends on the size and rate of exploitation of its reserves, relative to petroleum situation worldwide. However, with the longer term situation associated with the non-renewable resource problem, the government would not want to give up very much in short-term benefits, as compared with that given up to improve the country's absorptive capacity. All this boils down to the preference for breaking the absorptive capacity bottleneck rather than concentrating at this time on the non-renewable resource problem; but the latter still needs to be dealt with and should be part of Saudi Arabia long-run planning.

How long to identify, develop technology, and train for a major renewable industry vs. how much time Saudi

has? With prudent investments at home and abroad and with the small population base, Saudi Arabia probably has considerable time before its position becomes serious.

In summary, the efficiency criteria represented by the standard NPW method appears to be the best choice for Saudi Arabia. Income distribution takes on less importance, because of the Government's ability to tax and allocate the resources within the economy. Removing the absorptive capacity constraint through improved planning and technical assistance would seem to be the key strategy to Saudi Arabia's future growth. Such removal would seem to be a reasonable target provided suitable training is arranged either directly or through a form of subsidy by approving projects with strong training components and suitable technology but whose direct profitabilities are lower than those from international securities. Finally, Saudi Arabia needs to shift to renewable resources base appears to be more of a long-run objective, rather than short-run. By focusing on removal of the absorptive capacity constraint, the government would be acquiring the capacity.... through acquired technologies, trained manpower, and institutional change to more easily handle the shift from non-renewable to renewable resources when the need becomes more pressing.

CHAPTER 7

SHADOW PRICES

7.1 The Basic Principles in The Little and Mirrlees Approach

The social prices are needed for planning, because as we know that the condition of "perfect competition" must necessarily hold if we expect the market prices to reflect social marginal costs and benefits. That means all agents should behave as price takers and have no influence on the prices, which is not the case in real economies, particularly in the less developed countries. Also, there should be no externalities, no monopolies and no increasing return to scale, no market failure because of uncertainty, and there should be a right distribution of income and factor of ownership as Layard and Walters say⁽¹⁾ "each consumer is able to buy the consumption bundle which corresponds to the welfare - maximising configuration of the economy". In this respect the distribution of income is unequal in LDC's. So society cannot give the same social value to an increase in consumption of a rich person and of a poor person, unless there is total disregard of income distribution.

1. Layard, P. R. G. and Walters, A. A. Microeconomic Theory, McGraw-Hill Inc., London, 1978, p.27.

Little and Mirrlees argue that for the wage rate to represent the real social cost of employing one more man, there should be no underemployment or involuntary unemployment. This is not the case for most of the LDC's because they have a very serious employment problem.

So the domestic market prices do not represent social costs and benefits in reality. As Little and Mirrlees say: ⁽¹⁾

"The essence of cost-benefit analysis is that it does not accept that actual receipts adequately measure social benefits and actual expenditures social costs. But it does accept that actual receipts and expenditures can be suitably adjusted so that the difference between them will probably reflect the social gain. The prices used, after such adjustment have been made, will be called 'Social Accounting Prices' or for short 'Accounting Prices'.

This is the correct assessment of investment decisions and many other policy decisions, but many developing countries ignore it and pretend that public investment decisions, and the operation results of public enterprises, are to be taken on the basis of their private profitability. So many public enterprises behave as if the profit maximisation at the market prices is the objective, in the same way as the private enterprises do.

1. Little and Mirrlees, 1974, p.19.

From a social point of view, the activities of the public sector, and also those of the private sector, should be appraised not on the basis of their profitability at the market prices, but on the basis of their profitability at social prices.

Thus the need for social accounting prices for planning is both crucial and urgent for developing countries. Little and Mirrlees say:⁽¹⁾

"It is ironical that, in the past, planning was advocated for developing countries largely because the prices thrown up by a Laissez-Faire system could not be trusted to reflect national cost and benefits; but it has been used in such a way as to make the distortions worse".

7.1.1 World Prices as the Basis for Social Accounting Prices

The use of social prices based on world prices by Little and Mirrlees, because if we assume trading in the world markets is open to the public sector in any country, then world prices represent real opportunity costs or real marginal rates of transformation for the goods that are traded. Little and Mirrlees say:⁽²⁾

"Border prices can be used as accounting prices for all traded goods, because they represent the correct social opportunity costs or benefits of using or producing a traded good. If the use or production of a good is likely to affect exports of it, then one uses the FOB price and if imports, then the CIF price".

1. Little and Mirrlees, 1974, p.67

2. Little and Mirrlees, 1974, p.68

When the traded goods accounting prices have been defined as the corresponding export or import prices, then the accounting prices of the non-traded goods is left to be determined. In this respect, Little and Mirrlees argue that the valuation should be made on the basis of their foreign exchange equivalents, estimated with consideration of all the direct and indirect effects that the production of the non-traded good actually has on the balance of trade.

But to what extent is it correct to assume that the world prices provide appropriate guidelines to social cost-benefit analysis knowing that there are imperfections in the world markets and there is unequal distribution of income at the world level? This was discussed by Irvin⁽¹⁾, who claims that from the point of view of one specific country, the major concern should be the achievement of maximum social gains for both its present and future generations through the optimal exploitation of the resources that are available to it. Another objective concerns the country's efforts to improve the unjust allocation of world resources and the detrimental trend of the terms of trade for commodities.

1. Irvin, George, Modern Cost-Benefit Methods, The MacMillan Press Ltd., London, 1978, p.78.

However, these objectives are not contradictory. A country cannot paralyse its development waiting for the solution of those problems at the world level. Also the exploitation of our "comparative advantages" should not make us forget that we should also try to steadily contribute to get a new international economic order and try to correct the market imperfections at that level. Otherwise, in practice, the short-sighted exploitation of our comparative advantages may lead us, in the long-run, to an undesirable position.

7.1.2 The Social Dimension

Social dimension is another essential feature of the modern social cost-benefit analysis, ie. the consideration of the impact of public projects on the distribution of income. However, two different effects could be distinguished: on the inter-personal distribution of income and on the inter-temporal distribution of income.

Extra-income may accrue to certain income groups, as a result of a particular project, whereas an alternative project may bring extra-income to other income-groups. So should we attach different weights to the income accruing to different income groups.

The government should decide on this matter, and

corresponds to its position with respect to the prevailing income distribution. The weights would be same for all income-groups and "social value" of those increases in income as a result of alternative projects will be the same, no matter to whom they accrue if the government is totally indifferent with respect to the present income distribution. But if the government is prepared to contribute to the modification of that pattern, then the weights attached to the extra-income accruing to different income groups should be different. As a result, the "social value" of those increases in income of alternative projects will differ.

The Little and Mirrlees approach advantage to social cost-benefit analysis is that it allows for transparent account of inter-personal distributional issues, because it allows for the use of different distributional weights. This means that one extra dollar accruing to a rich person may not be seen socially as valuable as one extra dollar accruing to a poor person.

To express this by a quantitative way this is by means of parameter called "the elasticity of the social marginal utility of income" (ϵ) that measures how quickly the social marginal utility of income falls if we pass from a certain group to another.

The other way in which the social dimension could be considered is that the act of investment represents a way of using resources which could be otherwise devoted to increase the present level of consumption, we can conclude that investment is in fact a form of sacrificing consumption today in order to increase consumption tomorrow.

We have to discount future benefits by means of what is called the "Accounting Rate of Interest" (ARI), which could be regarded as the rate of fall of the value of the numeraire over time, if we want to make each unit of our numeraire exactly equivalent.

7.2 Building Blocks in the Little and Mirrlees Methodology

In the following we shall refer briefly to the main building blocks in the Little and Mirrlees approach to social cost and benefits analysis.

7.2.1 The Numeraire

The numeraire in any set of prices is just the particular good that is used as a yardstick in order to express all other goods in terms of it, so that they could be made comparable ie., when we express the market prices in terms of current money, "money" plays that role.

Also we need to choose a particular numeraire in

terms of which all social prices could be expressed in the social valuation of commodities and factors. The Little and Mirrlees numeraire is "present uncommitted social income measured in convertible foreign exchange".

The Little and Mirrlees say, the choice of the numeraire should not affect the relative values of the commodities nor the choice of projects, because it is only a matter of "conceptual and computational convenience".

The numeraire is defined as "uncommitted social income". Which means that all income occurring to the different income groups is socially valued, from the government's view point, with a particular set of distributional weights. So that "uncommitted social income" could be read as "income socially weighted from the government viewpoint".

Also the word "present" reminds us that all future benefits are to be discounted appropriately in order to express them on comparable basis.

Finally, the numeraire measurement in terms of "convertible foreign exchange" is based on Little and Mirrlees principle that accounting prices for commodities should be based on world prices.

Moreover, the presence of "convertible foreign exchange" in the numeraire makes things easier: it facilitates the estimation of the accounting rate of interest (ARI) as, approximately, the interest rate prevailing in the international financial markets where a great proportion of public investment may be financed.

7.2.2 The Accounting rate of Interest (ARI)

The ARI can be the rate of fall over time of the social costs and benefits occurring from the marginal project of the public sector. So the ARI would ideally correspond to the real rate of return from a project that just breaks even. Also the ARI correspond to the rate of fall of the numeraire through time (the social value of marginal increases in income to the critical income group).

The ARI is significant for the project appraisal, it is used to discount the net social profits accruing to the economy during the life-time of a project in order to get a single value (the Net Present Social Value) which will be used as a yardstick to decide whether the project should be undertaken or not.

In this respect Little and Mirrlees have set these two basic principles:⁽¹⁾

1. Little-Mirrlees, 1974, p.152

1. Future social profits must be discounted in exactly the same way for all projects.
2. The rates of interest must ensure that all mutually compatible projects whose present social value is positive, and only those should be undertaken.

So the "right ARI" is the one that passes just the right volume of projects as to be undertaken.

Another approach to the ARI is to consider the average rate of return for private investments at shadow prices, and regard it as an upper bound to the ARI, assuming that the marginal project available to the government shows lower returns than the average in the private sector.

Finally, an alternative procedure would be to relate the ARI to the expected rate of increase of the level of critical income g , to the elasticity of the social marginal utility of income e , and the rate of pure time preference p , so that

$$ARI = eg + P$$

This procedure seems to be useful for evaluating the consistency of the assumptions made, rather than

for giving an initial estimate of the ARI. So perhaps the most practical suggestion in this respect is to build a range of possible values and evaluate them all, and choose one as an initial estimate or alternatively, take the marginal borrowing rate abroad as the most sensible estimate.

7.2.3 The Traded and Non Traded Classification of Goods

Commodities can be categorised either as traded (exportables or importables) or non-traded. This is normally done looking at the likely effect of an extra demand or supply of them upon production, consumption and trade. If the most likely effect of an extra demand of a certain commodity is an increase in imports, then that good may be classified as importable. On the other hand, if an extra supply of a good will be exported, that commodity may be classified as exportable. However, if an extra demand or supply of a commodity will be an increase of domestic production or consumption, with no effects upon the balance of trade, that commodity may be classified as non-traded (see Table 7.1).

In this respect some remarks can be made. First, the analysis should be made on the basis of assumed marginal changes in the supply or demand of goods. Second, we should consider the ultimate effects of those marginal changes and not just the direct or

(Table 7.1)

TRADED/NON-TRADED CLASSIFICATION OF GOODS

No.	Industry	Case A	Case B
1	Agriculture Products	X	M
2	Forestry Products	NT	M
3	Fishing Products	NT	M
4	Food	NT	M
5	Drink	NT	M
6	Tobacco	NT	M
7	Textiles	NT	M
8	Wood	NT	M
9	Paper and Printing	NT	M
10	Oil Production and Refining	X	X
11	Chemicals	X	M
12	Other non-metallic minerals	NT	M
13	Basic and Fabricated Metals	NT	M
14	Machinery and Miscellaneous Manufacturing	NT	M
15	Electricity	NT	NT
16	Water	NT	NT
17	Construction - civil work	NT	NT
18	Construction - building	NT	NT
19	Construction - industrial	NT	NT
20	Construction - sub-contract	NT	NT
21	Wholesale trade	NT	NT
22	Retail trade	NT	NT
23	Hotel and Restaurants	NT	NT
24	Land Transport	NT	NT
25	Other Transport & Communication	NT	NT
26	Banking and Finance	NT	NT
27	Property ownership	NT	NT
28	Other Business Services	NT	NT
29	Personal and Miscellaneous Services	NT	NT
30	Repair of Household goods	NT	NT
31	Social and Community	NT	NT

Notation:

NT: Non-traded good

X: Exportable good

M: Importable good

primary effects.

Also in the classification of goods we should try to incorporate the man-made restrictions referred to trade. When a commodity is wholly exported it might be that there is a rigid quota that could not be avoided, so that additional supply of it may not necessarily result on increased export. It is the same with imports, when there are rigid import quotas imposed by the government.

To classify the good as traded or non-traded depends also on how rigid the quantitative restrictions are. If it is reasonable to assume that a quota extension could be obtained, the good may be classified as traded. Otherwise it should be classified as non-traded.

The case of export of goods that are subject to quantitative restrictions depends on how important the domestic demand of that good, as compared with exports. If the domestic demand is important, then that good can be classified as non-traded, because, an increase in domestic supply will probably increase domestic consumption. But if the domestic demand of that good is not significant and the main destiny of that good is exports, that good can be classified as traded good.

The future trade policies are also important, because we should not assess the likely effects of a marginal change in the supply or demand of a commodity just on the basis of what has happened up to now. We need to incorporate the data we have about trade policy in the future, in the light of what the government plans to do.

As in the standard Little and Mirrlees methodological procedure for determining a set of shadow prices at an economy wide level, the first thing we usually do is to identify the goods that are going to be treated as traded goods, which is assumed that a marginal increase in its demand or in its supply will directly affect the level of imports or the level of exports.

Second, for each traded good the ratio of its "world prices" to its "domestic prices" is estimated, so that a set of accounting ratios for traded goods is determined. With those accounting ratios at hand, the traded inputs into the non-traded activities are revalued at world prices. For that purpose it is enough to multiply those traded inputs, in our input/output matrix, by the corresponding accounting ratios for traded goods.

By using standard algebraic notation, if S_i^t are

the accounting ratios for the traded goods and X_{ij}^t are the requirements of traded goods for the production of one unit of non-traded good j , the social value of the m traded inputs into the non-traded activity j may be expressed, as total coefficient, by:

$$t_j = \sum_{i=1}^m S_i^t X_{ij}^t$$

In the basic approach, the Accounting Ratios for the non-traded goods are derived in a two-step procedure: First, the global (direct or indirect) requirements of traded goods and primary inputs for the production of one unit of output are estimated and, second, those global requirements are revalued at social prices.

The first step is the consists of the application of a rather standard input/output technique using the Leontief's Inverse Matrix. For instance, the global requirements of "labour" in the production of one unit of good j are given by:

$$L_j = l_1 a_{1j} + l_2 a_{2j} + \dots + l_n a_{nj}$$

or

$$L_j = \sum_{i=1}^{n-m} l_i a_{ij}$$

where

l_i are direct labour coefficients.

a_{ij} are the elements of the Leontief's Inverse Matrix corresponding to the non-traded inputs into the

non-traded goods.

$n-m$ is the number of non traded activities.

In the same way, the global requirements of traded inputs (T_j), of capital inputs (K_j) and of residual inputs (R_j) are obtained as:

$$T_j = \sum_{i=1}^{n-m} t_i a_{ij}$$

$$K_j = \sum_{i=1}^{n-m} k_i a_{ij}$$

$$R_j = \sum_{i=1}^{n-m} r_i a_{ij}$$

where t_i , k_i and r_i are the direct coefficients that correspond to traded, capital and residual inputs, and the a_{ij} are as before the Leontief's Inverse Matrix.

The "residual" elements are just the complements to unity of the sum of the coefficients corresponding to the traded and non-traded inputs, and those corresponding to the basic primary inputs (labour and capital). So the "residual" may include different elements as direct tax, "excess" profits, and the difference between the market value of the traded inputs and its world-price valuation.

Thus, by definition, for any non-traded activity j we will have:-

$$T_j + L_j + K_j + R_j = 1$$

In the basic model, the revaluation of the global requirements of each type of input is done with its own standard conversion factor, as a result of which the Accounting Ratios corresponding to the output of sector j is:

$$A_j = T_j + \lambda L_j + \phi K_j + \rho R_j$$

Unity, λ , ϕ , ρ and are the standard conversion factors for the traded inputs, labour, capital and the residual respectively. In this approach λ , ϕ , and ρ are taken to be the same across sectors. It is usually assumed that all "excess" profits accrue to the government because they are public sector projects or because the government will heavily tax all "excess" profits accruing in the private sector. When that assumption is made, the "residual" does not represent any social cost in terms of Little-Mirrlees numeraire. Hence, in the basic model a value of zero is commonly assigned to ρ , the standard conversion factor for the residual element.

7.2.4. Incorporation of the Different Types of Labour and Sector-Specific Conversion Factors for Labour in the Model

We will introduce sector-specific conversion factors for labour into the basic model and we assume for the time being that the skill-level of the labour force is homogeneous throughout the economy.

In the simplified model, the global requirements

of labour (ie. the global labour-costs component) for the production of one unit output in non-traded activity j was given as:

$$L_j = l_1^1 a_{1j} + l_2 a_{2j} + \dots + l_n a_{nj}$$

In that case the revaluation, at social prices, of those costs implied the use of single standard conversion factor for labour:

$$L_j^a = \lambda (l_1 a_{1j} + l_2 a_{2j} + \dots + l_n a_{nj})$$

However, under the assumption that the proportions of divergence between the SWR and the MWR might vary across sectors, instead of revaluing the global requirements of labour with single SCF, what is needed is to revalue each of its constituent elements (the direct plus indirect requirements of labour from each of the other sectors and from itself) with sector-specific conversion factors. So instead of the last expression we will have:

$$L_j^a = \lambda_1 l_1 a_{1j} + \lambda_2 l_2 a_{2j} + \dots + \lambda_n l_n a_{nj}$$

Now we can relax our assumption of homogeneity of the skill level of the labour force. This will mean that we will have three labour-costs coefficient for every activity instead of one. We will have one for unskilled labour, second one for skilled labour and

the last one for highly skilled labour. We denote them by l_i^1 , l_i^2 and l_i^3 . So the sum of all the three will reproduce our original coefficient l_i .

Then as we did in the case of a single labour category, we do for each of the three labour groups. Thus, the global requirement of unskilled labour by sector j is given by:

$$L_j^1 = l_1^1 a_{1j} + l_2^1 a_{2j} + \dots + l_n^1 a_{nj}$$

those for skilled labour by:

$$L_j^2 = l_1^2 a_{1j} + l_2^2 a_{2j} + \dots + l_n^2 a_{nj}$$

and those of highly skilled labour by:

$$L_j^3 = l_1^3 a_{1j} + l_2^3 a_{2j} + \dots + l_n^3 a_{nj}$$

The revaluation at social prices, of the global requirements of traded and primary inputs will include now the separate revaluation of the requirements of all three different kinds of labour with sector - specific and skill - specific conversion factors for labour.

When we denote the sector specific conversion factors for unskilled labour by λ_i^1 , those for skilled labour by λ_i^2 , and those for highly skilled labour by λ_i^3 , our expression for the Accounting Ratio of non-traded turn to be:

$$A_j = T_j + \sum \lambda_i^1 l_i^1 a_{ij} + \sum \lambda_i^2 l_i^2 a_{ij} + \sum \lambda_i^3 l_i^3 a_{ij} + \phi K_j + \rho R_j$$

However, taking into account that the role of most highly skilled workers such as engineers, teachers, and doctors is typically specific to each activity, we made the simplifying assumption that the social costs of the payments made to highly skilled labour are roughly equivalent to their market values, ie. that λ_i^3 could be taken as 1 for all activities. Then, our final expression for the accounting ratios of non-traded good is:

$$A_j = T_j + \sum \lambda_i^1 l_i^1 a_{ij} + \sum \lambda_i^2 l_i^2 a_{ij} + \sum l_i^3 a_{ij} + \phi K_j + \rho R_j$$

7.2.5 Incorporation of Various Types of Capital Goods in the (Implicit) Estimation of Sector - Specific Conversion Factors for Capital Inputs

The incorporation of the capital inputs into these economy-wide shadow pricing models basically responds to the need of considering the return to the capital invested in the various activities as one of the costs items that should be considered.

In the social cost-benefit analysis we usually refer to the social opportunity cost of using a certain type of resource. We should look at the alternative use of capital goods and estimate at social prices its product in the alternative occupations. But it is impossible to follow this procedure in practice at an economy wide level of

analysis, because capital goods are, to a great extent, sector-specific so that, in general, it is very difficult to assess their product in alternative occupations. Let us just imagine how we could estimate the opportunity cost of agricultural machinery, or refining equipment.

Another way in which this problem can be tackled: We may directly think in terms of the social return that the economy would expect to get from the use of the capital inputs that are needed to achieve a certain level of production. By social return we mean the Accounting Rate of Interest applied to the social value of the capital used.

We need to make it clear that when we refer to the requirement of capital inputs, we are not just referring to the direct use of capital inputs but to the global requirement of capital inputs. Then if, for the production of one unit of good j the use of capital goods with market value of K_j was directly and indirectly required; A_{kj} was the investment conversion factor and R was the social rate of interest:

$$RA_{kj} K_j$$

would be the social cost of the capital inputs associated with the production of one unit of good j .

This expression reminds us of the expression for the Accounting Ratio of non-traded goods, in which the global requirement of capital inputs, K_j was "revalued" with a single "standard conversion factor for capital inputs" ϕ . Hence ϕ could be defined as the Accounting Rate of Interest times the investment Conversion Factor.

The point we are making is that taking for granted that the ARI is, by definition, unique, the use of a single SCF for capital inputs amounts to the assumptions that the investment Conversion Factors are identical across sectors and that in turn, the composition of the capital stock, by type of capital goods, is the same for all sectors. This seems to be a very strong assumption. In reality, the composition of capital largely varies across activities. Obviously that is the case when comparing the capital structure of agriculture, mining, manufacturing, housing and banking for instance. What is more, capital goods corresponding to certain activities are typically imported goods whereas those corresponding to other activities are typically non-traded goods. Therefore, little hope exists for getting investment conversion factors that are invariant across sectors.

In view of all this, we decided to attempt the implicit incorporation of sector - Specific Investment

Conversion Factors in our model. We say "implicit" because the investment conversion factors are not incorporated as such: it is the distinct composition of capital that is explicitly incorporated so that each type of capital good is affected by its own accounting ratio.

Let us put some algebra into our analysis. If we think of the various types of capital goods that constitute the capital stock of sector j and build a matrix K^* with the elements K_{ij}^* that represent the direct requirements of the various types i of capital goods in the production of one unit output of good j , the matrix K of global requirements of capital inputs will be given by:

$$K = K^* (I-A)^{-1}$$

From what we have seen before, each element of the K matrix should be affected (multiplied by the accounting ratio corresponding to that type of capital good and by R , the social rate of interest). The social cost associated to the use of capital inputs required for the production of good j is:

$$\sum_{i=1}^{n-m} RA_i K_{ij}$$

This expression is the one that ought to be incorporated in our model if we are to consider the

distinct composition of capital assets across sectors. Specifically we should incorporate it in our expression for the accounting ratio of non-traded activity (instead of ϕK_j). Therefore:

$$A_j = T_j + \sum_i \lambda_i^1 l_i^1 a_{ij} + \sum_i \lambda_i^2 l_i^2 a_{ij} + \sum_i l_i^3 a_{ij} + \sum_i RA_i K_{ij} + pR_j$$

The Accounting Ratios for the non-traded goods are now explicitly depending on the Accounting Ratios of the Capital goods, a fact that remained hidden in the basic approach.

However, there is still something to say about the "capital inputs" and their social valuation. The analysis we have been doing implicitly considers that there is shortage of capital in the economy, ie. that the capacity constraints are binding. It typically corresponds, therefore, to a long-run type of analysis, and this is usually the one that is preferred in economy-wide shadow pricing exercises. But, it might also be interesting to accommodate our model to a short-run framework.

In the short-run we assume that the capacity constraints are not binding yet, so that there exists some degree of excess capacity throughout the economy. If that is the case, the opportunity cost of using

that part of the capital stock that is idle would be, obviously, zero. Hence, in the short-run, under the assumption of capacity idleness, the social cost associated with the use of capital is just zero. The only modification that this would entail, in terms of the model is the elimination of the element associated to capital inputs in the expression for the accounting ratio of the non-traded goods.

7.2.6 The Shadow Wage Rate (SWR)

Labour is one of the inputs to the non-traded activities, so we need to evaluate the marginal social cost of using it. The estimation of the appropriate social cost that one should associate with the use of labour turns out to be decisive for determining how labour intensive projects should be. If the social cost is low, we should select labour-intensive projects. So the estimation of the shadow wage rate has particular importance when there are high rates of unemployment or underemployment.

When estimating the social cost of employing one more person in a project we need to evaluate how much output the economy will lose as a result of drawing him from his previous occupation. This is "the output foregone", which should be measured at accounting prices. If the new worker is drawn from the unemployed, then the output foregone is zero.

Seton⁽¹⁾ has made an important contribution to the Little and Mirrlees methodology, for Little and Mirrlees original assumption was that the net effect of the creation of a new job would be the withdrawal of a worker from agriculture. Seton's assumption is that "the chain of departures and replacements" will probably lose many links on its way, since there would probably be many industries that will not replace all the workers that withdrawn.

Normally the new worker will be paid a higher wage than in his previous occupation, and he will increase his consumption. So that will require extra provision of goods and services that should be valued at accounting prices and regarded as a cost to the economy.

The increase in the worker income and consumption will also imply private benefits to the worker, which should be revalued from the social point of view, and expressed in terms of numeraire. These social benefits to the worker should be deducted from the cost, to finally obtain an expression for the SWR.

As we know that the worker could be withdrawn

1. Seton, Francis "Shadow Wage Rates for the Chilean Economy", OECD, 1972

from various activities in proportions which must sum unity, we can express:

$$SWR_j = \sum \pi_{kj} P_k A_k + \sum \pi_{kj} (C_j^a - C_k^a) - \alpha_j$$

where:-

π_{kj} are the proportions in which labour is ultimately withdrawn from various occupations when a job in activity j is created.

P_k is the marginal product (at market prices) of the departing worker in his previous occupation.

A_k are the accounting ratios used to convert the market values into social values.

$c_j^a - c_k^a$ is the increase in consumption, valued at shadow prices that results when a worker in occupation k shifts to occupation j .

α_j is the short expression for the social benefit attached to the creation of a job in activity j .

The elements c_j^a and c_k^a in the above expression correspond to the social value of the consumption by the workers and their families in activities j and k . Explicitly we can put them in terms of the accounting ratios A_i . If we allow for a distinct composition of the consumption baskets corresponding to different

groups, and denote by e_{ij} the proportion of the consumption baskets of group j spent in good i , and by c_j the consumption level of that group, the social value of the consumption will be given by:

$$C_j^a = \sum_{i=1}^m C_j e_{ij} A_i + \sum_{i=m+1}^n C_j e_{ij} A_i^t$$

Explicitly we have introduced a separate term corresponding to the consumption of $(n-m-1)$ traded goods. For group k , similarly:

$$C_k^a = \sum_{i=1}^m C_k e_{ik} A_i + \sum_{i=m+1}^n C_k e_{ik} A_i^t$$

The Accounting Ratios of exportable goods depend on the Accounting ratio of the trade and transport margins. So if T_i is the purely parametric element of accounting ratios for traded goods and M_i is the element that depends on the accounting ratio for traded and transport, then:

$$C_j^a = \sum_{i=1}^m C_j e_{ij} A_i + \sum_{i=m+1}^n C_j e_{ij} T_i - \sum_{i=m+1}^n c_j e_{ij} M_i A_i$$

The third term refers to a non-traded good, the same as the first term, so we can subtract the third term from the first one. Also, we can call the second term c_j^t , which is a number, and add it to α_j . The result of this is our final expression for the shadow wage rate turns to:

$$\begin{aligned}
SWR_j = & \sum_{k=1}^q \pi_{kj} P_k A_k + \sum_{k=1}^q \pi_{kj} (\sum c_j^t l_{ij} - A_i - \sum C_k^t l_{ik} A_i) + \\
& + \sum_{k=1}^q \pi_{kj} (c_j^t - c_k^t) - \alpha_j
\end{aligned}$$

we will have similar expressions corresponding to the SWR of unskilled and skilled workers.

7.2.7 The Traded Goods Accounting Ratio

In the basic model, the accounting ratios of non-traded goods appear to depend, unidirectionally, on the accounting ratios of traded goods. Also that the later ones, in turn, depend on the former ones, does not appear explicitly. Now our intention is to correct that situation and see how this further adjustment may affect the model.

The precise form that the expression for the accounting ratios of traded goods should take, greatly depends on the type of valuation system in which the input/output matrix is expressed.

The input/output matrix was valued at the basic prices. So the trade and transport margins corresponding to all inputs to a certain activity appeared consolidated as a separate input and a single figure. In that case we should consist in converting the market basic prices into social basic prices, bearing in mind that the trade and transport margins

appear as a different cost item which will be separately transformed into its social value.

The result of this, the accounting (basic) price of importable goods is just its CIF price, since it may be assumed that the distributional margins to put it at its point of consumption by the project are already considered as a separate input. So, at basic prices, the accounting ratio for importables is just:

$$A^M = \frac{CIF}{DOM}$$

In the input/output matrix the case of the exportables, the trade and transport margins that were saved because the good was not exported but used in the project are not considered.

So if the accounting (basic) price of exportable is its FOB price minus the accounting value of the margins saved by not exporting it, to convert the accounting ratio of exportable inputs at market basic prices into their social value equivalents is:

$$A^X = \frac{FOB (1 - A_M M^X)}{DOM}$$

or

$$A^X = \frac{FOB}{DOM} - A_M M^X \left(\frac{FOB}{DOM} \right)$$

This expression separates the purely parametric element from the element that depends on the

accounting ratio of trade and transport. This will lead us to an adjusted form of the expression for the accounting ratios of the non-traded goods.

So instead of having just T_j we will have now $T_j^1 - M^x A_j$, where T_j is now just referred to the CIF/DOM and FOB/DOM ratios, where M^x is exclusively referred to the margin element of exportables. The final expression of AR of non-traded goods:

$$A_j = T_j^1 - A_j M^x + \sum (L_i^1 a_{ij}) SWR_i^1 + \sum (L_i^2 a_{ij}) SWR_i^2 + \sum l_i^3 a_{ij} + \sum RK_{ij} A_i + \rho^c R_j^c + \rho^p R_j^p$$

7.3. The Expression of the Accounting Ratios of Non-Traded goods in Matrix Notation

The expression for the accounting ratios of non-traded good in matrix notation form is:

$$A = T - A_j M + U W^* + S W^{**} + \lambda^3 H + k^t + k^N A_k + \rho^c R^c$$

where:

- A: is the $m \times 1$ matrix of accounting ratios of the non-traded goods (unknown).
- T: is the $m \times 1$ matrix of global requirement of traded goods.
- M: is the $m \times 1$ matrix of global savings of trade and transport margins associated with the use of exportable goods as current inputs and capital inputs.
- U: is the $m \times m$ matrix of global requirements of unskilled labour, by unit of output, needed in all other activities as result of the project.

It is equivalent to a full detailed matrix of hirschmanian backward employment linkages.

S : is the $m \times m$ matrix equivalent to matrix U , but for skilled labour.

H : is the $m \times 1$ matrix of global costs of hiring highly skilled labour, by unit output.

K^t : is the $m \times 1$ matrix of global capital inputs that correspond to traded goods, by unit output. The distributional margins that might be associated to them are considered in matrix M .

K^N : is the $(m \times ?)$ matrix of global capital inputs that correspond to non-traded goods, by unit output.

R^c : is the $m \times 1$ matrix of global increase in pure profits accruing to capitalists, by unit output.

W^* : is the $m \times 1$ matrix of SWR's for unskilled labour (unknown)

W^{**} : is the $m \times 1$ matrix of SWR's for skilled labour (unknown).

A_a : is the accounting ratio for distributional margins.

A_k : is the $(? \times 1)$ matrix of accounting ratio for non-traded goods that affect capital goods.

λ^3 : is the standard conversion factor for the wages of highly skilled labours.

If we add up all the column vectors, which are independent of the unknowns, into one single column vector the expression can be simplified. So:

$$\Theta = T + K^t + \lambda^3 H + \rho^c R^c$$

Also, if A_k is the k^{th} element of A , we can express $A_k M$ as $M^* A$, where M^* is a $m \times m$ matrix of zeros whose k^{th} column has been replaced by the element of M . Hence:

$$A_k M = M^* A$$

A can also be expressed as IA . Therefore:

$$IA = UW^* + SW^* + \Theta = M^* A + K^N A_k$$

and:

$$ZA = UW^* + SW^{**} + \Theta$$

where:

$$Z = I - M^* - K^N$$

The whole expression for the set of unknown accounting ratios for the non-traded goods reduced now to:

$$ZA = UW^* + SW^{**} + \Theta$$

7.3.1 The Shadow Wage Rate Expression in Matrix

Notation

The final expression for the shadow wage rate as we saw before turns to be:

$$\begin{aligned} SWR_j = & \sum_{k=1}^q \pi_{kj} P_k A_k + \sum_{k=1}^q \pi_{kj} (\sum C_k^* l_{ik} A_i) + \\ & + \sum_{k=1}^q \pi_{kj} (c_j^t - c_k^t) - \alpha_j \end{aligned}$$

The first term refers to the output forgone at accounting prices. In principle, the origins of labour do not necessarily have to coincide with the

activities we have defined: one of the sources may be unemployment, for instance. That is why in general, a subscript of k instead of i was used. Also, the accounting ratios needed to convert the output forgone to its social value do not necessarily have to coincide with the accounting ratios we are working with: one may take an average, for instance.

The first problem, is that the origin of labour is not so important in this respect: we should be able to estimate the output foregone at market prices and also the corresponding income and consumption level whatever the origin of labour is. The second problem is the one that is relevant here: which is how to convert the market value of the output foregone to its social value, which accounting ratios to use.

It depends on the specific solution to the problem of determining the ultimate origins of labour. They turned to be the rural unemployed, the rural self-employed, the urban unemployed and the urban self-employed, for which even for the unemployed we assumed there was some output foregone.

The accounting ratio corresponding to agriculture seemed to be most convenient for those coming from the rural sector, although one can always argue about that. The accounting ratio corresponding to trade,

seemed to be the most convenient for those coming from the urban sector, mainly because this is one of the most important urban activities and usually a "hall" for people trying to get a job.

The reason for us to depart momentarily from our main object, which is to present the model in matrix notation because we need to explain why we can take, hereafter, the subscript "k" as specifically corresponding to a certain "i".

The first two terms in the last expression can be obtained as one single element: "the social cost of the output foregone and increased consumption in non-traded goods" since both depend on the accounting ratios of the non-traded goods.

The benefits of this simplification can be greatly appreciated in the matrix notation. The shadow wage rate of unskilled labour can be defined as:

$$W^{\dagger} = C^{\dagger} A^{\dagger} + C^{\dagger} - \Delta$$

where:

$W^{\dagger}$: is the (mx1) matrix of the SWR for unskilled labour (unknown)

$C^{\dagger}$: is the (mxm) matrix of "output foregone and increased consumption of non-traded goods" as a result of creation of a job in non-traded

activities.

A^n : is the (mx1) matrix of accounting ratios of non-traded goods (unknown).

C^t : is the (mx1) matrix representing the increased consumption of traded goods (already at shadow prices).

Δ : is the (mx1) matrix of the social benefits associated with the creation of a job in the non-traded activities.

Also the SWR of unskilled labour can be defined in a simpler expression as:

$$W^* = C^n A^n - \Delta^*$$

where

$$\Delta^* = C^t - \Delta$$

we also will have an equivalent expression for SWR for skilled labour:

$$W^{**} = D^n A^n - \Lambda^*$$

7.3.2. The Complete Model and its Solution

Now we can show that our model will consist of a system of 3m equations with 3m unknowns.

In matrix notation

$$ZA = UW^* + W^{**} + \Theta$$

$$W^* = C^n A^n - \Delta^*$$

$$W^{**} = D^n A^n - \Lambda^*$$

We can rearrange the system as

$$ZA - UW^* - SW^{**} = \Theta$$

$$CA - IW^* = \Delta^*$$

$$DA - IW^{**} = \Lambda^*$$

Therefore

$$\begin{bmatrix} A \\ W^* \\ W^{**} \end{bmatrix} = \begin{bmatrix} Z & -U & -S \\ C & -I & \\ D & & -I \end{bmatrix}^{-1} \begin{bmatrix} \Theta \\ \Delta^* \\ \Lambda^* \end{bmatrix}$$

will be the solution for the whole system.

We should notice that capital inputs will not be considered in the short-run cases. This will affect Z and Θ . Moreover, in case we consider that extra income accruing to the self employed and to capitalists might have different social values we would have to modify U and Θ .

Anyway, we can see that modifications are referred to the expressions for accounting ratios and not to the expressions for the SWR's.

The computation of the shadow prices was not obtained because the data is not available at this time, but when the data can be obtained it can be applied to the empirical work of this chapter and it could become a good topic for another thesis.

CHAPTER 8

Cost-Benefit Analysis

8.1 Introduction

Cost-benefit analysis is a technique for the evaluation of investment projects in the government sector, although it can be extended to any private sector project. It is different from the straightforward financial appraisal in that it considers all gains (benefits) and losses (costs) regardless of to whom they accrue. Then a benefit is any gain in utility and a cost is any loss of utility as measured by the opportunity cost of the project in question. CBA values all inputs and outputs at their shadow prices. In cost-benefit analysis we are concerned with the economy as a whole, with the welfare of the whole society, and not with smaller part of the society. Also the economist is concerned whether the society as a whole will become better off by undertaking this project rather than not undertaking it, or by undertaking instead any alternative project.

The economist substitutes the less precise yet meaningful concept of social benefit for the more precise concept of revenue to the private firm, for the cost of the private firm, the economist substitute

the concept of opportunity cost, for the profit of the firm, the economist substitutes the concept of excess social benefit over cost, or other related concept used in an investment criterion.⁽¹⁾

Professor Jackson⁽²⁾ stated that cost-benefit analysis has more specific meaning in economics:

"It is a means of setting out and comparing the factors that need to be taken into account when making choice between alternative public sector policies. The particular group of public policies to which CBA has been most frequently applied are those that involve public sector investment in capital projects, such as building a motorway, constructing a new reservoir, urban renewal, land reclamation, setting a new airport"

8.2 Brief History of Cost-Benefit Analysis

Cost-benefit analysis has been around a long time. Its analytical foundations go back in the writings of Jules Dupuit a nineteenth-century french economist, who in his classic paper on consumer surplus can be said to have laid the foundations

(1) E. J. Mishan, Cost-Benefit Analysis (Fourth Edition 1988)

(2) C. V. Brown and P. M Jackson Public Sector Economics (Third Edition 1986), p.190

which in modified forms still inform a great deal of contemporary work. The concepts defining social improvements were refined by an Italian social scientist Vilfredo Pareto, and later, by the british economists, Nicholas Kaldor and Sir John Hicks, in 1940. At about this time, evaluation was creeping in to official government activities. The U.S. flood control act of 1939 first enunciated the now familiar standard that "the benefits to whomsoever they may occur be in excess of the estimated costs." but gave no specific guidance on how to define costs and benefits.⁽¹⁾ Tinbergen (1956,1967) was amongst the first economists who strongly recommended the use of shadow prices for the appraisal of social worthwhileness of investment projects. Little and Mirrless (1969-1974) contributions were made which can be directly related to the work done by Tinbergen (1967). Marglin (1963) and Sen (1968) have provided major inputs into the discussion. Dasgupta, Marglin and Sen's work was sponsored by (UNIDO) has been compared with the work done by Little - Mirrless which was sponsored by OECD, which was discussed in the last chapter.

There are two major approaches to cost-benefit analysis, the first goes back to the Marshallian surplus analysis as revived by Hotelling (1938) and by

(1) Edward M. Gramlich "Benefit-Cost Analysis of Government Programs", (1981, p.7

Hicks (1941). The appeal of the surplus approach has proved very strong for certain economists for estimating the net loss to an economy because of the pressure of various distortions. Harberger (1971) used the surplus approach probably more forcefully than any other economist. Willing (1976) has argued that the Marshallian measure which is strictly valid only on the assumption of the constancy of the marginal utility of money can serve as good enough approximation even when this assumption is not strictly valid. The surplus approach can be described as a partial equilibrium approach even though Harberger (1971) has questioned it and a formal extension to the n-commodity case had been worked out by Hotelling. The extension depends on a mathematical theorem which need not to be valid in the large for a market demand function.

The other approach is the programming approach which views the cost-benefit analysis as a part of the decentralized planning procedure, which is connected with the maximization of an overall social welfare functions subject to various side conditions. Shadow prices are the correct estimates of costs and benefits which can be utilized for evaluating a given project.⁽¹⁾

(1) The New Palgrave a dictionary of Economics.
Edited by John Eatwell, M. Milgate and P. Newman,
1987.

8.3 The Appropriate Investment Criteria

Projects yield a stream of benefits and costs over a period of time. It is necessary to somehow aggregate monetary benefits and costs over time in order to obtain a single measure of the net social benefit of a project. The appropriate investment criteria is the present value of a project:

$$PV = \sum_{t=0}^T \frac{B_t - C_t}{(1 + r)^t}$$

If the $PV > 0$ the project would be undertaken, because it increase society's welfare. On the other hand if $PV < 0$ the project would be rejected since it would reduce economic welfare.

There are other criteria often used for assessing the viability of a project such as the internal rate of return and the benefit-cost ratio.

The internal rate of return (IRR) of a project is defined as the discount rate that make the present value of a project zero. If we denote the IRR by λ it will be defined by:

$$0 = \sum_{t=0}^T \frac{(B_t - C_t)}{(1 + \lambda)^t}$$

If the IRR or λ is more than the social discount rate r the project has a positive present value $PV > 0$ the project would be undertaken, and vice versa. If the

social discount rate r varies from period to period, the IRR criterion may no longer be useful.

The benefit-cost ratio (B/C) always indicates whether or not social welfare is improved when the project is undertaken. It is defined as the present value of benefits divided by the present value of costs, or:-

$$\frac{B}{C} = \frac{\sum_{t=0}^T B_t / (1 + r)^t}{\sum_{t=0}^T C_t / (1 + r)^t}$$

The benefit-cost ratio (B/C) will be greater than one or less than one as the present value is greater than or less than zero. The present value is the difference between the present values of benefits and costs while B/C is their ratio.

The B/C and IRR indicate whether or not a project will increase or decrease social welfare, but they may rank alternative projects incorrectly in terms of their contributions to economic welfare. One cannot rely on them as criteria for choosing the project that maximizes the contribution to social welfare. In the case of B/C this is due to the fact that the project scale is not explicitly considered.

When present value criterion is used one must

exercise some caution when the project evaluator is faced with a fixed capital budget that cannot be exceeded, and when there are several projects to choose from.

The benefits and costs occurring in the future may be known only with some degree of uncertainty. One may attach probabilities to various outcome occurring.⁽¹⁾

8.4 Measurement Problems of Cost-Benefit Analysis

The major measurement problems associated with the government projects in cost-benefit analysis are:-

1. Intangibles.
2. Shadow prices.
3. Indirect Benefits and Costs

The solutions to these measurement problems are different. Now we will consider each of them briefly.

8.4.1 Intangibles

Intangibles are benefits or costs that are impossible to evaluate in a monetary terms.⁽²⁾ Examples are: the saving of time in the transportation

(1) R. W. Boadway Public Sector Economics, 1979, p.178.

(2) R. W. Tresch Public Finance a Normative Theory, 1981, p.481.

projects (saving of travel time); the loss of life from environmental damage.

The project evaluator's job is to measure the value of these costs or benefits in monetary term. The principles to be followed in evaluating the values for intangibles in a monetary terms are identical to those for items sold and bought in the open markets - the total cost of an intangible is the minimum amount that would be accepted by the bearers of the cost in order to willingly bear it, and the total benefit of an intangible is the maximum amount of money that the users are willing to pay in order to have the services of it. The marketed inputs and outputs prices serve as the indicator of money values, with intangibles the money values must be from sources other than the market data, often indirectly from market behaviour elsewhere.⁽¹⁾ To show how the monetary values attached to intangibles, we consider the following example of saving time in transportation projects.

8.4.1.1 The Value of Time Saved:-

The largest benefits of transportation projects are the saving of travel time. If the projects save travel time the required compensating variation (CV) is equal to the largest amount of money a person is

(1) R. W. Boadway Public Sector Economics, 1979, p.188

willing to pay in order to save that amount of time. The value of a person's time equal to the sum of money he can earn during the time saved.⁽¹⁾

Saving time is valuable since the time saved travelling can be devoted to other activities such as work or leisure. The value of time saved can be the value of the increase in output or the wage rate. The value of substituting leisure time for commuting time is not directly reflected in market prices. The wage rate does not reflect the leisure time value, because if an individual allocate his time between leisure and work so that at the margin he will be indifferent between taking more work or taking more leisure. The benefit of taking more leisure is equal to the opportunity costs which is the foregone wage payments which yield consumption benefits and the forgone benefits of working. Algebraically:

$$MB_L = W + MB_W$$

MB_L is the marginal benefit of leisure time.

W is the wage rate.

MB_W is the marginal benefit of work.

$$MB_L < W$$

$$MB_W < 0$$

The individual would reduce his commuting time to

(2) E. J. Mishan Cost-Benefit Analysis, 1988, p.305

zero, but this is not possible and the individual must take a fixed amount of commuting time equal to the benefit of the increased leisure time less the benefit of the commuting time foregone.

$$\begin{aligned} V_c &= MB_L - MB_C \\ &= W + MB_W - MB_C \quad MB_C < 0 \end{aligned}$$

V_c is the value of a reduction in commuting time. MB_C is the marginal benefit from time spent commuting. Since both MB_W and MB_C are negative ($MB_W < MB_C$), then V_c will be less than W . The values of V_c are about one - quarter of the gross wage rate.⁽¹⁾

8.4.1.2. The value of Lives Saved or The cost of Loss of Lives.

This is another example of how monetary values could be attached to intangibles.

Many projects cause a loss or a saving of lives, or cause a change in the health of individuals. The increased probability of saving lives associated with many projects such as health expenditure programmes (e.g. immunization, or research and development), but other projects increase the probability of death or illness to individuals. The

(1) R. W. Boadway Public Sector Economics, 1979, pp.188-190

most obvious cases of these are nuclear power plants, or transportation projects which have an influence on lives or health through accidents.⁽¹⁾

Public sector economists universally agree that this type of intangibles ought to be included as a project cost or benefit, but they disagree over whether or not the life of a person is measurable, and if so, how to do it.

According to Mishan⁽²⁾, "the most common way of calculating the economic worth of a person's life and, therefore, the loss to the economy consequent upon his decease, is that of discounting to the present the person's expected future earnings"

$$L_1 = \sum Y_t P_{\tau}^t (1 + r)^{-(t-\tau)}$$

L_1 is the loss to the economy

Y_t is the expected gross earnings of the person during the t^{th} year.

P_{τ}^t is the probability in the current, or τ^{th} , year of the person being a live during the t^{th} year.

r is the social rate of discount during the t^{th} year.

Another method of calculating the economic worth

(2) R. W. Tresch Public Finance Normative Theory, 1981, pp.330-332

(1) E. J. Mishan Cost-Benefit Analysis, 1988, pp.330-332

of a person's life, is that of calculating the present discounted value of the losses to others over time as a result of this person's death at age τ . An expression for the loss to the economy would be:-

$$L_2 = \sum_{t=\tau}^{\infty} P^t (Y_t - C_t) (1+r)^{-(t-\tau)}$$

L_2 is the loss to the economy

C_t is the personal expenditure of the person during the t^{th} period that is expected at time, τ .

This kind of measure referred to as being based on the "net output" approach, in order to distinguish it from the L_1 measure that is associated with the "gross output" approach.

The measurement of the benefit of saving lives to the society is the same as the measurement of any other benefit. It is the maximum amount of money that the individual is willing to pay to secure the reduction in lives lost. The cost to society of any project that increases the number of death is the minimum amount of money that would be accepted by those bearing the cost in order to accept the increase. There are many benefits to society from a decrease in lives lost⁽¹⁾:-

(1) R. W. Boadway Public Sector Economics, 1979, p.193.

- a) The reduction in future resources costs expected to be achieved by the saving of resources brought about by a reduction in physical damage such as damage to vehicles, roads, as well as medical and funeral expenses incurred.
- b) The benefit to society if a project reduces deaths would be the increased net output available to society due to the reduced deaths, and the cost to society is the foregone net contribution of the deceased to the rest of society, which includes the present value of the individual's future output less the future consumption.
- c) The benefit to society is the reduction in the psychic costs to relatives and friends, that accompanies the death of an individual.
- d) The benefit to members of society from a reduction in the risk of death to all the members of society. It is the maximum amount of money that all individual would be willing to pay to decrease the risk.

8.4.2 Shadow Prices

Shadow prices is another measurement problem associated with government projects. The shadow pricing requirement arises when the market prices do not reflect social values as explained in the previous chapter.

The evaluation of costs and benefits requires the computation of shadow prices which are different from the market prices whenever there are market imperfections throughout the economy or if government policy responses are constrained in any way such as financing government projects by the use of distorting taxes⁽¹⁾. There are three important applications of shadow pricing: those to labour, foreign exchange, and public funds.

8.4.2.1. Shadow Price of Labour

The labour market distortions can arise for a variety of reasons: some distortions between demand and supply prices or wage rates. The costs of moving from one location to another can cause a wage differential for the same type of labour in different industries and in different regions. The existence of involuntary unemployment will show that there is a difference between the wage rate at which the workers would be willing to work and the market wage rate. The labour market in the less developed countries has a different wage rate, the wage rate received by the urban worker may exceed the wage rate paid to the rural workers who migrate to the cities trying to find employment. The additional worker demanded by the project could be

(1) R. W. Tresch Public Finance and Normative Theory, 1981, p.482.

drown from three sources: some may have been employed elsewhere at the market wage. The opportunity cost of this forgone demand elsewhere is the gross wage paid there. Some might come from the voluntarily unemployed. This will represent an increase in the supply of labour and should be valued at the net wage since this reflect the amount of money they must be paid in order to induce the worker into the labour force. Some may be drawn from the involuntarily unemployed. The opportunity cost of employing each of these workers is their supply price of labour, but the supply price of labour is not observed in the market which make it very difficult to estimate the shadow wage rate. It must be below the net wage otherwise there will no involuntarily unemployment. It is above zero since the workers presumably attach some positive value for leisure time⁽¹⁾. In any case the shadow price of labour will not be the price paid by the project, and, therefore the measure of costs in cost-benefit analysis will be different from the financial costs actually incurred.

8.4.2.2 The Shadow Price of Foreign Exchange

The foreign exchange market may be distorted by tariffs, quotas, or any other sort of controls, the price of foreign exchange rate may be distorted.

(1) R. W. Boadway Welfare Economics, 1984, p.302.

Therefore the project evaluators construct a shadow price of foreign exchange to measure the opportunity cost of the net foreign exchange required for the project. The supply of foreign exchange comes from the sales of exports. The exports supply is a function of the existing exchange rates e . The higher is the price of foreign exchange e , the higher the price in domestic currency received from the exports sale and the more will be purchased for export. The demand for foreign exchange depends on the foreign price plus the tariff. The shadow price of foreign exchange P_f , would be:

$$P_f = e \frac{\Delta E}{\Delta G} - e(1+t) \frac{\Delta M}{\Delta G}$$

ΔG is the net demand for foreign exchange by the project.

ΔE is the change in exports.

ΔM is the change in imports.

The amount ΔG will include the sum of the value of the tradables produced less the value of the tradables used.

If there are many exports and imports each with different distortion, then the shadow price of foreign exchange will be:

$$P_f = e \frac{\Delta E}{\Delta G} - \sum_{i=1}^n e(1+t_i) \frac{\Delta M_i}{\Delta G}$$

t_i is the tariff rate.

The idea behind the computation of the shadow price of foreign exchange is to convert the foreign exchange into its equivalent domestic monetary value. If the countries have distortions such as tariff, then their exchange rate will be overvalued, and the shadow price of foreign exchange will be greater than the existing exchange rate⁽¹⁾.

8.4.2.3 The Social Opportunity Cost of Public Funds

The cost of public projects are raised by funds either through taxation or through issuing of bonds, because public projects are not self-financing because the benefits are not all captured in revenues or because the project exhibits economies to scale. A cost-benefit analysis must consider the shadow pricing of all inputs and outputs, also it must include any additional opportunity costs incurred as a result of the requirement to meet financial losses through the provision of public funds. The public project financing may use funds that otherwise would be used for private investment. The opportunity cost of the private investment forgone is the present value of the consumption that would be yielded in the private sector by the investment.

The general rule for evaluating projects when

(1) R. W. Boadway Public Sector Economics, 1979, pp.184-85.

some of the revenue raised from public funds was developed by Feldestein (1972), by using the present value⁽¹⁾:-

$$NPV = \sum_{t=0}^T \frac{NB_t - (a-1)D_t}{(1+r)^t}$$

NB_t is the net benefits ($B_t - C_t$).

r is the social discount rate.

D_t is the financing requirements of the project.

$(a-1)$ is the deadweight loss per pound of financing.

In a given year D_t could be positive or negative. It would be negative when revenues exceed costs, and the contribution of the project to public funds would reduce the welfare loss by $-(a-1)D_t$.

8.4.3 Indirect Benefits and Costs

The importance of these indirect benefits and costs depends on the project under consideration. Some time they are negligible; in others they are significant.

In principle the external effects that ought to be included in a cost-benefit analysis are those which affect the consumers utility or the firms production possibilities without being priced. The pecuniary

(1) R. W. Boadway Welfare Economics, 1984, p.309.

externalities must not be included because it has already been included in the measurement of the costs of production used on the project⁽¹⁾.

The benefits and costs of externalities are very difficult to evaluate in monetary value. It is the same as that of measuring intangibles already discussed. The project evaluator's job is to measure the benefits by the maximum amount of money that the party benefiting would be willing to pay in order to have the project proceed. As an example:- the transportation services provided by the underground or by the train. The indirect benefit would be the reduction in road use. External costs are the minimum amount that would be acceptable to the damaged party to allow the damage to be done. As an example of the external cost consider the noise pollution caused by living near the airport. The cost of the noise pollution is the depreciation in the house prices⁽²⁾.

8.5 The Choice of a Social Discount Rate

The choice of a social discount rate of interest is crucial to any investment analysis. Using too high rate of interest, efficient projects will not be chosen. In the other hand if too low rate of interest

(1) R. W. Boadway Public Sector Economics, 1979, p.195.

(2) R. W. Boadway, p.196.

is used, then inefficient projects will be chosen by the government, especially those whose returns occurs far into the future.

There are three broad approaches towards the determination of the social discount rate. One approach characterised by the work of a group of economists such as Harberger, Sjaastad and Wisecarver. They argue that the rate of discount remains an opportunity cost of public funds, as much as the discount rate of the private investment measures the opportunity cost of capital of the firm. The second approach is the work of another group of economists, Marglin, Arrow, Feldstein, believes that the discount rate simply reflects society's rate of time preference, the social marginal rate of substitution between the future and the present. They argue that the discount rate in cost-benefit analysis has nothing to do with the opportunity cost. The third approach by Diamond, McKean, argue that the discount rate is not associated with concepts such as opportunity cost or time preference. Rather they believes that the discount rate is simply another shadow price that will depend on the structure of the environment, as all shadow prices do. Under some assumptions the appropriate discount rate is the opportunity cost of public funds, and under different assumptions the appropriate discount rate is the society's rate of preference.

But it is possible to have other assumptions under which there is no relationship between the discount rate and either concept⁽¹⁾.

All public sector economists agree that the present value of government projects depends upon three factors:- (a) The opportunity cost of public funds, (b) society's rate of time preference, and (c) the degree to which the net benefits of government projects are reinvested or consumed.

8.6 The problem of Risk and Uncertainty

The costs and benefits for most public projects will occur in the future, and also involve displacement of private sector costs and benefits which occurred in the future. But the future is uncertain, and this uncertainty causes a problem for public or private investment, because most people are risk averse which means that they would be willing to pay a premium to change uncertain returns to a certain return. The cost of risk is the minimum amount of money that must be paid to the individual in order to compensate him for taking the risk. We can distinguish between an uncertain situation in which the probability of outcomes are not known, and a risky situation in which these probabilities of various

(1) R. W. Tresch Public Finance Finance a Normative Theory, 1981, p.479.

outcomes are known⁽¹⁾.

There are two decision rules:- maximin and minimax. The decision maker might assume the worst and use the maximin strategy which maximizes the return on the worst outcome. Or, he might assume that all possible outcomes chance of occurring are equal and utilize those probabilities. The minimax regret decision rule tries to give any wrong making decisions penalty points. The decision maker will choose the project with minimum of the maximum regret.⁽²⁾

If the individual level of income is faced with some risk, and there is probability π_1 that the income will be Y_1 , and a probability π_2 that it will be Y_2 , where $\pi_1 + \pi_2 = 1$ then the expected value of risk would be:-

$$EV = \sum_i \pi_i Y_i = \pi_1 Y_1 + \pi_2 Y_2$$

Since the income Y_1 and Y_2 have utilities $U(Y_1)$ and $U(Y_2)$ associated with them, the expected utility would be:-

$$EU = \sum_i \pi_i U(Y_i) = \pi_1 U(Y_1) + \pi_2 U(Y_2)$$

(1) R. W. Boadway, Public Sector Economics, 1979, p.201.

(2) C. V. Brown and P. M. Jackson Public Sector Economics, 1986, p.204.

That is the possible outcomes of the expected utility is a weighted average of the utilities, the weights being the probabilities of outcomes occurrence.

The cost of risk-bearing is defined as "the reduction in expected value that the individual would accept in order to have a certain income rather than the risky expected income".⁽¹⁾

In cost-benefit analysis the cost of risk-bearing is important in the calculation of the opportunity cost of public funds, the projects that require public funds for their support, these funds will come from the forgone investment or foregone consumption. The opportunity cost of the forgone investment calculated by taking the present value at the social discount rate of the stream of consumption generated out of the gross returns to capital in the private sector ρ . When all returns are consumed the present value is ρ/r where r is the social discount rate. If the gross return in the private sector include premium to cover the risk-bearing costs, the private sector no longer has to incur the risk-bearing costs. The private sector net loss is the $\rho - k$ where k is the risk premium, and the opportunity cost of public funds would be:-

(1) R. W. Boadway Public Sector Economics, 1979, p.202.

$$a = (1-\theta) + \frac{\theta(\rho-K)}{r}$$

The public projects' risk-bearing cost may be negligible, because of risk-spreading and risk-pooling.

Risk-pooling occurs when the government has many small projects with independent probability distribution. The cost of risk-bearing will be low, because the society has many independent projects and the risks of each tend to offset each other.

Risk-spreading occurs when a large number of individuals share the benefits and costs of a project. If the public projects are financed out of tax revenues risk-spreading takes place among taxpayers. As the number of individuals increases the cost of risk-bearing per individual decreases.⁽¹⁾

8.7 The Experience of Saudi Arabia

Saudi Arabia's entrance into the petrochemical industry which is a capital intensive industry, because of the cost advantages in the petrochemical industry over industrial countries the low cost of local raw materials, mainly natural gas which is

(1) R. W. Boadway, p.203.

usually flared in this country, the good location, and that the petrochemical industry would be another source of energy and income. The increase of revenue from oil after the price increases of 1973-74 helped Saudi Arabia to invest heavily in large scale-heavy industries such as the petrochemical industry without incurring the problem of foreign exchange shortages, also the rapid increase in the prices of petrochemical products which most developing countries import from developed countries encouraged the developing countries such as Saudi Arabia to develop their own industries.

There are other cost disadvantage such as the capital cost, labour cost, and the lack of domestic market for petrochemical products.

8.8 The Major Benefit

The Saudi government and the foreign partners who have great experience in the petrochemical industry initiated wide and careful studies before launching the petrochemical industry. They believe that a successful petrochemical projects could be achieved, because of the many cost advantages which would enable the Saudi petrochemical products to compete in the world market. The availability and cheap energy and feedstock is the key issue in cost advantages.

8.8.1 Low Cost of Raw Materials

The petrochemicals are manufactured economically from oil and natural gas which are available and cheap in Saudi Arabia more than any other country, because of the huge reserves of oil and gas, also many oil fields are being discovered every year. The utilization of natural gas in Saudi Arabia contributes effectively to the low cost of petrochemicals, because it will provide the lowest price in the world; natural gas will be supplied as fuel and Feedstock at 50¢ per million BTU. The average price in the United States was approximately \$2.00 per million BTU in 1979. The basic feedstock for petrochemicals, ethane, will be provided at about \$.56 per thousand cubic feet in Saudi Arabia, which is about one fifth of the world market price.

The Saudi Minister of planning indicated that energy and Feedstocks account for as much as 70 percent of the production costs.⁽¹⁾ This indicate that Saudi Arabia has a comparative advantage in the cost of production in the petrochemical industry. In the long-run the supply of raw materials would be secured. In the end of 1974, Saudi Arabian oil reserves were estimated to be 137 billion barrels while the associated gas produced by ARAMCO reached 4,422

(1) H. Nazer, Chemical Marketing and Reporter, October 28th 1985, p.3

million cubic feet per day. Only 17.8 percent of the produced gas being utilized while the remaining part was flared away.⁽¹⁾ The opportunity cost of the flared gas is nil as viewed by the planner. The supply of natural gas is sufficient to sustain ongoing investment in the petrochemical production. This is an advantage that many industrialized countries does not have.

8.8.2 The Good Location

The petrochemical plant locations are very important. It is preferable to locate the plant near raw material sources and the market. The raw material is natural gas, so it will be better if the plant is located near the gas field, because of the high cost and other difficulties in moving natural gas to the plant location.

In the industrial countries such as the United States, Canada and northwestern Europe, the petrochemical industries were grouped in centers usually where gas was available. The cost of transporting raw material is an important factor in determining the total cost of input.

The petrochemical plants are concentrated in

(1) Second Development Plan (1975-1980) Ministry of Planning, p.140.

Jubail city in the eastern province of Saudi Arabia where oil field are very close. The strategic location of Saudi Arabia supports its prospects to export to many countries all over the world. Saudi Arabia is located in an area that connects Asia and Africa and not far away from Europe. The international trade of petrochemicals will be filling potential needs in some Middle East countries, African countries and Southern Asia.

The location of the other petrochemical plants in Yanbu, which is located near the Red sea, which is closer to Europe than any other port in the Arabian Gulf, tends to give it special advantage over other plants in the Gulf countries.

8.8.3 Another Source of Energy and Income

Saudi Arabia cannot for ever depend upon the oil sector as a source of revenue, the benefit from investing in the petrochemical industry is to diversify the national income, the diversification of the economic base would minimize oil dependency and reduce any adverse impact of external shocks on the economy. The downstream industrialization (i.e. vertical integration of the oil industry) would create new added value to oil and natural gas. The international demand for petrochemicals was envisioned to be more diversified than that for oil, so that

their production would provide a hedge against fluctuation in the world oil supply and demand.⁽¹⁾

The non-renewable resources conversion to the production of the petrochemicals would in the absence of oil exports, enrich the society and enhance economic growth for several generations to come. The crude oil would be depleted within a forty-five year period, if the 1974 production of 3,095 million barrels of oil were maintained.⁽²⁾

The international trade would increase the benefit to Saudi Arabia, the petrochemical technology and expertise would be imported from Western nations. The imported technology would stimulate investment in the human capital, thus supplying the industries involved with a cadre of technologically trained workers. It has already been started that interdependency between Saudi Arabia and the world is a welcome idea. Therefore, the Saudis indicated that the level of oil exports would be influenced by the extent of the free-world cooperation in the Saudi industrial efforts.

(1) F. Akhdar Multional Firms and Developing Countires: A Case Study of the Impact of the Arabian American Oil Company "ARAMCO" on the Development of the Saudi Arabian Economy, Ph.D. dissertation at UCR, 1974.

(2) Facts and Figures (1970-1982), Ministry of Planning, p.113

8.8.4 The Environmental Condition

The petrochemical industry in Saudi Arabia has one added comparative advantage which is the relative freedom of their area from environmental worries of the intensity that make it hard to find sites for petrochemical plants in the industrialized countries.

The industrial countries' problem is not only the construction of the petrochemicals industry, but of maintaining the strict environmental regulation imposed on them. The pollution control requirements to protect the environment from air pollution, water pollution, disposal problems and the climate changes, represent a major cost problem. Although efforts have been undertaken to decrease pollution, such as building tall smokestacks, improving the plants, installing devices to limit sulphur oxides, nitrogen oxides, carbon monoxide and other gas emissions, but the growing pollution is still one of the most critical problems facing the industrialized countries. The world chemical companies who participated in Saudi Arabian petrochemical projects gave some consideration to environmental restrictions imposed on their expansion in the industrial countries, because many power plants and others such as the petrochemical plants that need cooling systems, use a cooling tower that recycles water to avoid damage to water resources, and this adds substantially to the cost of production. For example, the cost of a cooling tower

reaches \$22 million, compared with the cost of the plant \$300 million.⁽¹⁾ The cost of reducing the impact on the external environment to an acceptable level for a typical petrochemical plant accounts for about 12 percent of the total investment cost and 2 percent of the annual value of all output in industrial countries.⁽²⁾

Also, the indirect cost to the environment should be taken into consideration in raising the petrochemical products cost.

The new industrializing countries such as Saudi Arabia have less air and water pollution than the industrializing countries. The petrochemical industry in Saudi Arabia will start without intensive environmental requirements, because they use clean air and water, the Saudi population is about fourteen million spread over one million square miles and the energy consumption is limited. The petrochemical industrial cities, Jubail and Yanpu, are hidden in the desert far away from cities and do not threaten public health, also the cost of disposal of wastes will not be as much as in the industrialized countries.

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- (1) Richard C. Dorf, Energy and Resource Policy (Reading, Massachusetts Addison Westley, 1978), p.427.
- (2) Organisation For Economic Cooperation and Development, The Petrochemical Industry (Paris, 1979), p.33.

This cost advantage of the environmental expenditure will increase the competition of the Saudi petrochemical industry in the world market.

However, this possible advantage may become a potential threat to the Saudi environment in the future with the extensive expansion of the petrochemical industry unless very strict environmental measures are implemented during the early stages of development. Since the Saudi petrochemical industries are state-owned, it will be much easier to implement such measures at this stage. When some of these plants' ownership has been turned over to the public, the Saudi government will have to assure that the implementation of these environmental measures will continue. The Saudi petrochemical industry can benefit from the industrialized world experience, without repeating the same mistakes, in managing chemical wastes. Transfer of technology in this field is an essential step, and can be accomplished either through the foreign partners to these plants, or through direct contracts with companies manufacturing them. The measures to deal with chemical waste by having a sanitary landfill for the disposal of the wastes produced appears to pose a potential future danger. The Europeans have learned of the disadvantages of using waste landfills, and started to use other sophisticated techniques. One

have what is known as "bug pits" in which heavy organic chemical-eating "bugs" digest the petrochemical effluents.⁽¹⁾

In both cities Jubail and Yanbu, all means of preventing air and water pollution are used. It is planned that the waste water originated in the industrial complex is to be collected, treated and when possible, reused for irrigation and other purposes. Air purification devices are to be installed to reduce the level of air pollution resulting from the smoke of different petrochemical plants.

In the United States, 60 percent of the hazardous wastes come from the chemical industry. The Environmental Protection Agency (EPA) of the United States emphasizes that the total hazardous wastes produced in the United States between 1960 and 1980 are estimated to be from 330 to 570 million metric tons, some of which have been eliminated, while a significant portion has been kept in over 100,000 industrial disposal sites.⁽²⁾ The treating and disposing of hazardous waste in the United States is a \$400 million business in 1982 and it is expected to

(1) B. Reuben and M. Burstall. The Chemical Economy (London, Longman Group, Ltd., 1973), p.477.

(2) S. Senkon and N. Stauffer, "What to Do With Hazardous Waste" Technology Review, November 1981, p.36.

grow to an annual volume of around \$1.5 billion by 1985.⁽¹⁾

The chemical wastes and the polluted air produced by petrochemical industries is very serious, and it is deeply felt in the industrialized countries. In Europe, for example, the disposal of chemical waste has been a major problem facing industries there. The case of what is called "international smuggling of chemical waste" is constantly increasing. A large smuggled dump containing aromatic solvents and other petrochemical waste was found in Holland in 1981 beneath a school and housing development in the small town of Lekkerkerk.

The future of Saudi petrochemicals is to face this environmental threat. Their success will depend not only on how much production and sales they achieve, but to a certain extent it will depend on how well they maintain the regional environment and protect it from deteriorating below desirable standards.

8.9 The Major Cost Disadvantage

The petrochemical industry in Saudi Arabia is affected by some disadvantages: capital cost and

(1) J. Corbert, "Hazardous Wastes Managers Are Cleaning Up" Chemical Business, June 28, 1982, p.16.

labour cost.

8.9.1 Capital Cost

In a developing country such as Saudi Arabia, almost all machinery and equipment required for establishing a petrochemical plant has to be imported from the developed world. The insurance and transport costs, therefore, have to be added to the final capital cost. These costs will vary depending on the distance between the location of the country and the equipment supplier country and how it is transported.

Another factor that affects capital cost is the rate of inflation which has risen rapidly for the last 10 - 20 years in the world, including Saudi Arabia. This will affect the construction costs directly since almost all machinery and equipment, and some other services required for building and installing the plant, have to be imported from developed countries as mentioned earlier.

Other factors such as the climate, engineering materials, infrastructure (port facilities, roads, electricity, water and other services) and political stability will also directly affect the capital cost.

A study made by Shell Chemical Company in 1979 compared the cost of building two plants, one in the Arabian Gulf and another one in Europe. "It was shown

that the location alone would make capital cost 35 percent higher in the Gulf, whereas, if the need for additional infrastructure was taken into consideration, the cost would be 67 percent higher."⁽¹⁾

In western Europe, a 400,000 ton per year ethylene cracker cost about \$2.6 billion in 1979. The same plant would cost about \$4.0 billion in the Middle East, including the cost of transportation. This 50 percent increase in total cost results from the availability of equipment, materials and highly skilled labour and other needs in Europe. The following comparison shows the difference in costs in millions of dollars.⁽²⁾ Also Table 8.1a and Table 8.1b shows the production of Petrochemicals in Saudi Arabia and UK.

Table 8.1

	Europe	Middle East
Materials	\$1,500	\$ 2,000*
Labour	900	1,500 to 1,900
Other	200	300
Total	\$2,600	\$ 4,000

* including transportation

The disadvantage of high capital cost in Saudi Arabia could be offset by other factors. While total

(1) H. C. Hambleton, The Saudi Petrochemical Industry in the 1980s ed. by El-Mallakhs in "Saudi Arabia: Energy, Development Planning and Industrialisation", p.54.

(2) H. G. Hambleton, p.55

TABLE 8-1a

SAUDI'S MAJOR PETROCHEMICAL PLANTS: THEIR PRODUCTION AND COST

NAME OF PLANT	ONSTREAM	COST	PRODUCTION
Gulf Petrochemical Industries Company (GPIC)	1985	\$450m	Methanol 330,000 tpa Ammonia 330,000 tpa
Saudi Petrochemical Company (SADAF)	1984	\$3bn	Caustic soda 377,000 tpa Ethylene 656,000 tpa Ethylene dichloride 454,000 tpa Styrene 295,000 tpa Industrial ethanol 281,000 tpa
Arabian Petrochemical Company (PETROKEMYA)	1985	\$1.5bn	Ethylene 500.000 tpa
Al-Jubail Petrochemical Company (KEMYA)	1985	\$1.1bn	LLDPE 260,000 tpa (Linear Low Density Polyethylene)
Eastern Petrochemical Company (SHARQ)	1985	\$1.5bn	LLDPE 130,000 tpa Ethylene glycol 300,000 tpa

TABLE 8-1a (continued)

NAME OF PLANT	ONSTREAM	COST	PRODUCTION
National Methanol Company (IBN SINA)	Late 1984	\$500m	Chemical grade methanol 700,000 tpa
Saudi Methanol Company (AL-RAZI)	1983	\$500m	Methanol 600,000 tpa
Saudi European Petrochemical Company (IBN ZAHR)	1988		Methyl tertiary butyl ether (MTBE) 500,000 tpa
Saudi Yanbu Petrochemical Company	1985	\$2.5bn	Ethylene 455,000 tpa LLDPE 205,000 tpa HDPE 100,000 tpa Ethylene glycol 200,000 tpa

Source: C. Montagu, Industrial Development in Saudi Arabia, Report published in London by the Committee for Middle East Trade, November 1987.

TABLE 8-1b

PRODUCTION OF SELECTED PETROCHEMICALS BY UNITED KINGDOM
(tonnes)

PRODUCT	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Ethylene	1,235,464	1,115,400	1,154,646	1,324,276	1,446,514	1,474,693	1,797,855	2,005,188	1,975,358	1,490,803
Propylene	736,586	770,634	831,904	975,782	973,226	856,929	885,273	847,956	796,846	640,293
Butadiene	207,901	228,799	237,678	259,222	297,631	190,837	231,425	239,674	225,905	195,128
Ethanol	160,328	183,585	-	-	-	-	-	-	-	-
Acetone	111,231	135,258	121,754	161,452	146,795	123,177	117,854	127,459	130,327	128,462

Source: General Statistical Office, Business Monitor Quarterly Statistics, Business Statistics Office, from different issues 1981 up to 1990.

requirement is high in Saudi Arabia with the increased scale of production, per unit capital cost will be minimized through comparative advantage is raw material.

Robert C Crane⁽¹⁾ states that "although construction costs will remain at least 50 percent higher for plant in Saudi Arabia than in the industrial world, these can be amortized against income from lower Saudi operating costs".

8.9.2. Labour Cost and Labour Shortage

Most developing economies have a labour surplus. But in the case of Saudi Arabia the labour shortage is the major constraint of the development process. The shortage of Saudi manpower exists in all levels: unskilled, semi-skilled, skilled, managerial, technical and others, which result in many manpower problems.

Saudi labour productivity was relatively low by international standards when the oil boom came. The majority of the population was employed in the low-productivity agricultural sector as Table 8.2 shows. By 1980 one quarter of the workforce was still employed in agriculture. The dependence on expatriate

(2) R. C. Crane, Planning the Future of Saudi Arabia (New York: Praeger Publishing Company, 1976), p.29.

TABLE 8.2

CIVILIAN EMPLOYMENT IN THE NON-OIL SECTOR

Producing Sector	Employment 1975 (000)	Employment 1980 (000)	Change in employment (000)	Annual Growth Rate in		Annual Growth Rate in	
				Employment 1975-1980 (%)	Employment 1985 (000)	Employment 1980-1985 (%)	Employment 1985 (000)
Agriculture	502.6	598.8	96.2	2.9	528.8	-2.5	
Other mining	3.4	7.3	3.9	16.5	9.8	6.1	
Other Manufacturing	74.4	104.2	29.8	6.8	164.2	9.5	
Utilities	16.1	31.5	15.4	14.4	47.0	8.3	
Construction	172.3	330.1	157.8	13.9	245.1	-5.8	
Total Producing Sectors	961.2	1071.9	110.7	2.2	994.9	-1.5	
Services Sectors							
Trade	153.6	310.6	157.9	15.1	339.6	1.8	
Transport	114.5	214.6	100.1	13.4	274.6	5.1	
Finance	13.1	34.8	21.7	21.6	44.8	5.2	
Other Services	230.0	482.3	252.3	16.0	505.3	1.0	
Government	246.7	321.0	74.3	5.4	421.0	5.6	
Total Services Sectors	757.9	1363.3	604.5	12.5	1585.3	3.1	
Overall Total Civilian Employment in Non-oil	1719.1	2435.2	716.1	7.2	2580.2	1.2	

Source: Third Development Plane (1980-85) pp.37, 100, 101

labour was unavoidable to fill the gap of both quality and quantity for domestic needs and to achieve the desired high rate of growth.

Between 1975 and 1980 the non-Saudi workforce grew on average by 16.5 percent per annum, increasing from 494,000 to 1060,000. About 80 percent of the increase in the total civilian labour in this period, therefore, was accounted for by the growth of non-Saudi employment. In 1980 over 40 percent of the total workforce was non-Saudi.⁽¹⁾ Unskilled foreign labour dominated the construction industry, while skilled foreign labour clustered in the technologically-intensive industries as the petrochemical industry.

The overhead and direct labour cost, which was classified by the petrochemical producers as fixed in the short-run, represents a relatively high share of the total costs of the Saudi petrochemical production. Ragaei El-Malakh stated that "... the median annual salary for scientists and engineers in the United States is about \$30,000 while in Saudi Arabia 60,000 a year".⁽²⁾

(1) J. R. Presley A Guide to the Saudi Arabian Economy, 1984, p.44.

(2) R. E.-Mallakh Saudi Arabia Energy, Development Planning and Industrialisation, 1982, p.54.

The labour cost in Saudi Arabia is 50 percent more than the United States. This puts the proportion of labour cost to total operating cost at a high rate ranging between 20 - 30 percent of total variable cost per unit of product. For example, in 1980 the cost of labour in the petrochemical industry in Saudi Arabia was almost double that of a similar industry in Mexico and Brazil.⁽¹⁾ The reason was that the latter two countries employed local people while the first depends on foreign skilled labour. Depending on foreign labour would result in a higher production cost per unit, a slowing down in the development of local skilled labour and the creation of social and economic problems. In the meantime, the foreign skilled labour in the industry could be a great help in training labour, mainly by on-the-job methods. Another cost which is directly related to labour are maintenance costs. For Saudi Arabia maintenance is done by contractors located abroad. Also, some maintenance materials, parts, and workers are imported from the western world.

So, the high cost of labour and maintenance are another cost disadvantage to the petrochemical industry in Saudi Arabia.

(1) Second World-Wide Study on the Petrochemical Industry Process of Restructuring, 1981, Annex II.F, pp.37-38

8.10 Long-Run Solutions

The solution in the long-run is to encourage the growth of the Saudi labour force and increase the average productivity level of workers by the following:

8.10.1 Education

Education quality and quantity at all levels, is the main base for skilled labour development. The larger the number of students in a country, the larger the potential of skilled labour. The educational structure in Saudi Arabia is similar to many western countries, the only exception being that boys and girls are taught separately. Elementary education between the ages of six and twelve is followed by the intermediate education between the ages of twelve and fifteen and then the secondary between the ages of fifteen and eighteen. Table 8.3 shows the enrolment of these groups. Higher education in a variety of subjects is available at the Universities of King Saud, King Abdul Aziz, King Faisal and University of Petroleum and Minerals. Students wishing to graduate in religious studies at the Islamic University, Imam Mohammed Bin Saud university and Umm Al-Qura University. The number of students enrolled are shown in Table 8.4

The increase in the number of students obviously

TABLE 8.3

FOURTH PLAN ESTIMATES OF GENERAL EDUCATION ENROLMENT
AND NEW ENTRANTS

<u>STUDENT CATEGORY AND LEVEL</u>	<u>1984/85</u>	<u>1989/90</u>	<u>AVERAGE ANNUAL GROWTH</u> (Percent)
	<u>Number</u>		
Male Enrolment			
Elementary	672,000	841,000	4.6
Intermediate	168,000	217,000	5.3
Secondary	74,000	110,000	8.2
Female Enrolment			
Elementary	476,000	676,000	7.3
Intermediate	115,000	166,000	7.6
Secondary	64,000	95,000	8.2
Male New Entrants			
Elementary	123,000	142,000	2.9
Intermediate	59,000	86,000	7.8
Secondary	26,000	40,000	9.0
Female New Entrants			
Elementary	107,000	139,000	5.3
Intermediate	50,000	74,000	8.2
Secondary	27,000	40,000	8.2

Source: Kingdom of Saudi Arabia Ministry of Planning Fourth Development Plan, 1985-1990, p.276.

TABLE 8.4

STUDENTS IN HIGHER EDUCATION IN THE FOURTH PLAN PERIOD*
(Estimated Numbers)

New Entrants	1984/1985			1989/1990		
	Male	Female	Total	Male	Female	Total
KSU	5,280	1,355	6,635	5,970	1,590	7,560
KAAU	1,810	850	2,660	2,189	1,516	3,705
KFU	696	446	1,042	1,027	608	1,635
UPM	1,171	-	1,171	1,650	-	1,650
Islamic University	898	-	898	1,261	-	1,261
Imam Mohammed U	3,370	-	3,370	4,515	-	4,515
UAU	1,395	1,084	2,443	1,620	1,380	3,000
Girls Colleges	-	5,349	5,349	-	6,595	6,595
TOTAL	14,584	9,034	23,568	18,232	11,689	29,921
<u>Total Enrolment</u>						
KSU	17,536	4,891	22,427	18,730	5,670	24,400
KAAU	10,089	3,994	14,083	16,379	6,095	22,474
KFU	1,965	1,185	3,150	3,535	1,861	5,396
UPM	3,496	-	3,496	4,533	-	4,533
Islamic University	3,400	-	3,400	4,630	-	4,630
Imam Mohammed U	9,344	-	9,344	14,970	-	14,970
UAU	5,654	4,084	9,738	6,470	5,480	11,950
Girls Colleges	-	14,172	14,172	-	20,000	20,000
TOTAL	51,484	28,326	79,810	69,247	39,106	108,353

Cont/...

	1984/1985			1989/1990		
	<u>Male</u>	<u>Female</u>	<u>Total</u>	<u>Male</u>	<u>Female</u>	<u>Total</u>
<u>Graduates</u>						
KSU	1,868	547	2,415	2,820	560	3,380
KAAU	1,041	500	1,541	990	475	1,465
KFU	220	110	330	410	185	595
UPM	469	-	469	600	-	600
Islamic University	743	-	743	830	-	830
Imam Mohammed U	978	-	978	1,900	-	1,900
UAU	424	429	853	720	600	1,320
Girls Colleges	-	2,050	2,050	-	2,910	2,910
TOTAL	5,743	3,636	9,370	8,270	4,730	13,000

*Excludes non-regular male and female students in KAAU and Iman Mohammed University

Source: Kingdom of Saudi Arabia Ministry of Planning Fourth Development Plan, 1985-1990
p.289.

reflects an improvement in the potential for skilled labour. However, we should not always judge this by the number of students only. In a country like Saudi Arabia, which is seeking industrialization, we should not ignore the quality of the students.

Despite the impressive developments that have been achieved in education, it cannot be said that the country is without problems in education, or that these problems are easy to solve. Saudi Arabia is a country like any other developing country. It has its problems. One of the major problems is the shortage of national teachers which is caused by the rapid growth in education. As Bederly said:

"In contrast to most Arab countries Saudi Arabia faces the problems of abundance rather than of poverty. The major obstacle to the rapid development of the society is the critical shortage of trained Saudi manpower. Unlike most developing countries, which must contend with the dissatisfaction of a large number of unemployed intellectuals and university graduates, Saudi Arabia literally cannot produce graduates fast enough to meet its needs, especially in technical fields."⁽¹⁾

8.10.2 Technical Education and Vocational Training

Saudi Arabia's need for technicians, skilled and semi-skilled, is very critical, because most of the

(1) NYROP, Richard F. (Editors). Area Handbook for Saudi Arabia, Washington D.C., American University, 1977, p.96.

technical manpower working in the kingdom at the present time are foreigners who need to be replaced by Saudis. So the government established the General Organisation For Technical Education to be in charge of technical education which is under the Ministry of Education. It offers a variety of engineering courses including mechanical, electrical, automotive and civil engineering. By 1980 there were six vocational schools existing in the country and a technical, industrial institute and Royal Technical Institute. Their capacity is over 6000 students but the actual enrolment less than one-half of this number.⁽¹⁾

To improve and develop vocational and technical education the authority plans to provide sufficient financial allocation, developing the present technical and vocational institution and opening new institutes and technical colleges, encouraging more students by giving high grants, by providing pre and inservice training and by employing the best teachers.

8.10.3 Training and Distribution of Labour:

The kind of training depends on the labour skill and on the nature of the job. The majority of unskilled workers are illiterate which makes training

(1) J. R. Presley, A Guide to the Saudi Arabian Economy, 1984, p.117.

more difficult because training requires a level of literacy in order to help the trainee to read instructions and follow them. High rates of illiteracy slow down the process of training and distribution of labour.

An efficient distribution of labour must direct the right person to the right job. This would help to increase the output, decrease losses from the misuse of capital equipment and create more suitable grounds for technology transformation. In order to do this, a full survey of the ability, interest, past experience and the background of workers is needed. Then the needed training could be determined and the worker directed to the right job. Also a good survey may discover workers who were classified as unskilled in one job, and they could be used as semi-skilled or skilled, with the help of training in another job. So shifting a labour from one job to another need training in order to prepare the worker for his new job.

A great help in the process of labour distribution is an efficient management which provides the industry with the required skilled labour and identify workers for training. The improvement of managerial personal specially those at the top are needed by appointed qualified and experienced persons

and by regular training. Then we can obtain a better and efficient distribution of labour.

8.10.4 Change in the Methods of Work and the Technique of Production

The labour movement between industries is caused by some factors such as high wages, low work hours and better work conditions. Most workers will stay in their present jobs or return to their previous jobs after the distribution take place if there is no improvement in their work condition.

The improvement of production techniques is necessary because one of the main reasons of labour distribution is to increase the productivity of labour. Also, since labour training should always be updated, capital equipment must also be modernised. By changing the technique of production to the better, one can expect a better base for skilled labour creation and then the level of production will be better from both workers and the industry.

The development of highly technical industry such as the petrochemical industry would improve the labour skill and would foster the development of new techniques of production in many other industries in the country. So it is necessary to change in the methods of work and the technique of production to

increase the productivity level of workers. So efficient work conditions (housing, transport and other services) should be made available. The supply of foreign labour should be limited in terms of quantity and quality and the type of workers.

8.11 Water Shortage

The availability of water supply in a sufficient quantity and acceptable quality is a necessary condition for social and economic development in any country. Saudi Arabia major problem for development is the availability of water. There are no lakes or rivers and little rainfall which makes sweet water more scarce than oil.

The water resources development is determined by the demand and supply relationship. The population growth, living standards and economic development determine the quantity and quality of water demand; on the other hand the availability of water determines the scale and location of longer term development⁽¹⁾.

8.11.1 Development of Water Resources

To cope with the shortage of water and the increasing demand by the expanding urban population,

(1) Kingdom of Saudi Arabia Ministry of Planning, Fourth Development Plan, 1985-1990, p.133.

and industrial development. The government increase the water supply by building dams in many locations.

he two largest dams are Wadi Juizan with a capacity of 71 million cubic meters, and the Abha dam which holds 10 million cubic meters. During the Third Development Plan (1980-85), 124 new dams were constructed, additional water supply developed by drilling 715 wells for the purpose of water supply, aquifer testing and observation of water levels, the drilling of 162 wells for water supply to Riyadh and 57 wells in the Eastern Region. Large numbers of wells for agriculture developed by the private sector.

Desalinated sea water provided a significant addition to fresh water supplies. The desalination plant in Saudi Arabia is the largest in the world.

The Saline Water Conversion Corporation (SWCC) was operating 20 water desalination plants by 1985; 15 on the West Coast and 5 on the East Coast. The total of useable water capacity increased almost tenfold 400 million cubic meters per year. Also during the same period of time SWCC completed the 460 kilometer dual water pipeline from Jubail to Riyadh with maximum design capacity of 830,000 cubic meters per day⁽¹⁾.

(1) Kingdom of Saudi Arabia Ministry of Planning
Fourth Development Plan, 1985-1990, p.136

Saudi Arabia gets around 50 percent of its supply of water from the desalination plants and the other 50 percent from underground reservoirs.⁽¹⁾

Another development of water resources in its early stages is the reclamation of waste water, and it requires extensive treatment and control in accordance with strict water quality standards. During the period 1980-1985 improvement of sewerage networks and treatment technology resulted in the ability to utilise this resources for irrigated landscaping and industrial uses, but not for human consumption. In 1985 about 100 million cubic meters per year of reclaimed waste water had been made available for use. These supplies are expected to double and will be available near large cities by 1990.

8.12 Water Cost and Over Consumption

The cost of producing water in Saudi Arabia is very high and the people are charged low prices for using it. The water desalination is very expensive, the cost of producing one cubic meter is about \$2.0, while the consumers pay only \$0.15 a cubic meters. The reason for government subsidies is to keep the

(1) R. El-Mallakh Saudi Arabia Energy Development Planning and Industrialisation, 1982, p.12

cost of living as low as possible, but the low cost encourages consumers to waste water and consume more than they need.

By the year 2000, Saudis are going to consume about 4 billion cubic meters of water, then the opportunity cost of the water consumption would be at least \$8 billion (\$2.0 x 4), that is almost one-third of the entire government budget⁽¹⁾.

The high cost of water is one of the disadvantage in the Saudi petrochemical industry because it increases the cost of production. Without the government subsidies the industry would be charged at least \$3.20 a cubic meter instead of the going price of \$0.66 a cubic meter⁽²⁾. Even with the subsidies the cost of processed water is still higher than that in the Western World, it is 320% higher than on the US Gulf coast.⁽³⁾

The immediate solution to the problem of high cost of water, and the shortage expected in the future

(1) R. El-Mallakh, 1982, p.13.

(2) Indicators of Downstream Industries. Ministry of Finance and Natural Economy, 1984.

(3) Petrochemicals from Saudi Arabia CHEMTECH. February 1986, p.97.

should be to increase the price of water to the consumers, the public should be informed about the problem and the high cost and the importance of water. Also installing new technology for saving water in all sectors of the economy could be an effected policy. To decrease the over consumption by raising the price of water to its real cost and offer the subsidies back to the consumers as a "lump sum", By doing this the consumer would receive a subsidy which might increase their real income without encouraging them to waste water.⁽¹⁾

The government expenditures for water sectors during the period 1985-1990 are shown in Table 8.5 and 8.6.

8.15 Other Alternatives

The petrochemical industries were considered economically feasible for Saudi Arabia, because of the cost advantages in energy and raw materials. So any export-oriented projects in Saudi Arabia must be related to oil and gas production.

(1) R. El-Mallakh Saudi Arabia Energy Development Planning and Industrialisation, 1982, p.13

TABLE 8.5

WATER SECTOR PROGRAM EXPENDITURE
(1985-1990)

	<u>Fourth Plan Total</u>
	SR Million
<u>Ministry of Agriculture and Water (Water Affairs)</u>	
Water Management	90.0
Water Resources Development	2,260.2
Drinking Water Supply	6,814.6
Operation and Maintenance	652.2
Sub-Total	<u>9,817.0</u>
<u>Saline Water Conversion Corporation</u>	
Development and Construction	14,156.2
Operation and Maintenance	5,563.8
Administration	1,216.2
Sub-Total	<u>20,936.2</u>
Expected Revenues	<u>320.5</u>
<u>Al-Hassa Irrigation and Drainage Authority</u>	
Management, Operation and Maintenance	946.0
Research, Studies and Development of Water Resources	43.0
Construction	37.5
Manpower Development	10.0
Sub-total	<u>1,036.5</u>
Total	<u>31,789.7</u>

Source: Kingdom of Saudi Arabia Ministry of Planning
Fourth Development Plan 1985-1990, p.147

TABLE 8.6

MUNICIPAL AND PUBLIC WORKS
PROGRAM EXPENDITURES

(1985-1990)

<u>Ministry of Municipal and Rural Affairs</u>	<u>Fourth Plan Total</u> (SR Million)
Water	11,185
Sewage	12,079
Rainwater Drainage	1,216
Flood Control	536
Markets	448
Public Utilities	4,301
Municipal Streets	9,277
Government Buildings	379
Environmental Improvement	38
Planning	768
Training	70
Others	22,103
Sub-total	62,400
 <u>Deputy Ministry of Public Works</u>	
Management and Administration	600
Operation and Maintenance	18
Ongoing Construction	357
Development and Consultancy	125
Sub-total	1,100
Total	63,500

Source: Kingdom of Saudi Arabia Ministry of Planning
Fourth Development Plan, 1985-1990, p.409.

1. Consider for example, industries based on agriculture which are not feasible in the desert. The poor soil quality, scarcity of water, and shortage of labour hindered the agriculture activities. Ground water and surface water fell short of the requirements to meet the agricultural activity. The reliance on the desalinated seawater to irrigate the agricultural crops would be unprofitable and very costly. Even though only half a million hectares of the 4.5 million hectares of the arable land was being cultivated in 1970/71, unfavourable climatic condition are detrimental to the growth of agricultural sector.⁽¹⁾
2. One could ask why petrochemical rather than exporting LNG as an alternative? To answer the question: first the cost of transportation of petrochemical is very low compared to LNG. The geographic location of Saudi Arabia with respect to the international market makes the transportation cost of the liquified natural gas very high. The difficulties of transportation of liquified natural gas was explained in the Petroleum Economist:⁽²⁾

(1) R. El-Mallakh Saudi Arabia: Rush to Development 1982, p.80.

(2) Petroleum Economist "Prospect for the Natural Gas Trade", Editorial, May 1986, p.158.

"The biggest cost, however, may be that of transport to market, for this involves a huge capital investment. Pipelines are far more expensive than for oil, because gas has low energy density, while costly compressors, storage accommodation and other ancillaries are required. More expensive still is the transport of gas by sea, since this calls for highly sophisticated LNG carriers, as well as liquifaction and regasification facilities.

It is the burden of transport costs that limits the scope for international trade and impose severe penalties on gas producers remote from main markets".

Therefore, manufacturing petrochemicals and exporting the unneeded liquified gas are the best way to decrease the cost of transportation especially for Saudi Arabia which is far away from Europe and US than other gasproducingregions around consuming countries. According to the price of 1978, a barrel of oil worth \$12 can generate goods which worth about \$84. When it moves downstream to produce a common plastic such as polyester or chemicals, its price could increase one hundred times.⁽¹⁾ The same products can be manufactured from natural gas, which was exported to the industrial countries at lower prices than oil.

3. Another question could be why invest in petrochemical and not invest the oil money abroad and live on the proceeds?

(1) L. Turner and J. Bedore, Middle East Industrialisation, (New York: Praeger Publishers, 1979, p.17)

Local investment preferred more than the foreign investment as a means of alleviating the country's immediate problems. Infrastructure projects were to be constructed to enlarge the absorptive capacity of the economy and thus help to ease the high inflation rate. Also the return to Saudi Arabia in the form of interest in the foreign investment market ignores the world inflation levels which decrease the earning level of interest to a very low level and could result in a negative interest rate in the long-run.

"According to a study of the Arab Monetary Fund in Abu Dhabi, Arab cash balances in Western countries have been depreciating nearly 5 percent per annum in real terms in recent years. Consequently, the Saudi government realised the desirability of converting its accumulation cash surpluses into actual investments within the Kingdom in order to minimise the decapitalisation of its international financial assets".⁽¹⁾

The financial assets also are subject to the fluctuation of the foreign currencies such as dollar devaluation which make investing abroad less attractive.

"The barrel of oil sold now may well yield a revenue that cannot be invested domestically. This must then be invested abroad which means that the capital sum involves risk with respect to foreign-exchange fluctuations or freezing. For

(1) Farouk Akhdar, The Philosophy of Saudi Arabia's Saudi Industrialisation Policy, ed. by El-Mallakhs in "Saudi Arabia Energy, Development Planning and industrialisation", 1982, p.16

example, in terms of 1974 dollar prices, the \$129.5 billion foreign assets of OPEC that are denominated in dollars would be only \$75.1 billion in early 1979 simply because of dollar devaluation".⁽¹⁾

4. Other observers could ask, why petrochemical industry rather than aluminum processing which is also energy and capital intensive industry? the aluminum industry was planned in Jubail only to provide the domestic market rather than to be exported to the international markets, because aluminum depends heavily on raw materials such as "bauxite" which is not available abundantly in Saudi Arabia. The raw materials transportation cost would be doubled which would eliminate the competitive pricing in the international market. Also from the technological point of view, many companies were able to develop new technologies that will improve more efficient plants in energy consumption. One company "claimed to have developed a new smelting technique that save up to 30 percent of the energy input required for primary smelting, that company is planning a capacity expansion of 450,000 tons per year on the strength of the new process".⁽²⁾ Also the

(1) L. Turner and J. Bedore, Middle East Industrialisation 1979, p.37.

(2) P. J. Stevens, The Interaction between Oil Policy and Industrial Development Planning and Industrialisation", p.42.

possibilities for recycling aluminum on a large scale which would save 95 percent of the energy input to primary smelting are being explored: "one estimate suggests that by 1985, 34 percent of US aluminum consumption will be met from recycling compared to 23 percent in 1978"⁽¹⁾. All these changes in the aluminum industry prove that the petrochemical industry for Saudi Arabia is the best alternative.

(1) P. J. Stevens, p.42.

CHAPTER 9

MARKETING PETROCHEMICALS

9.1 INTRODUCTION

The petrochemical industry in Saudi Arabia is mainly export-oriented, because the domestic market is small in size and could not absorb the goods produced by an expanding industrial sector. However Saudi Arabia has had little or no experience in marketing Petrochemicals.

This is why the Saudi planners hesitate to enter the petrochemical market alone without partners with previous experience. The joint-venture policy with large and well-known multinational chemical companies in the petrochemical projects will guarantee marketing the product profitably. According to SABIC officials:

"It has been an essential part of the Kingdom's strategy to ensure its trouble free integration into the world petrochemical scene by entering into partnership with established major companies in the field which will thereby have the incentive to make way for the future output from Saudi Arabia through a rationalisation of their facilities elsewhere".⁽¹⁾

All the foreign partners are obligated to market

(1) "SABIC Director Sees Bright Future for Saudi Industries as Gulf Emerges as New World Petrochemical Center" Middle East Economic Survey (MESS) February 8th, 1982, p.1

more than 50 percent of the joint-venture products in the US, the Arab world, Japan and Africa.

The multinational firms were very beneficial for the Saudis to complement their efforts in penetrating the world market, because the multinational firms are familiar with the international marketing distribution network more than SABIC. The foreign firms signed marketing contracts with SABIC in order to market 50%-75% of the products. For example, Celanese was obligated to market 75 percent of methanol produced by Ibn-sina plant. The marketing agreement between SABIC and Celanese was as follows:

1. "Celanese shall take or pay 75 percent of the plant production".
2. "SABIC or a SABIC marketing affiliate shall have the option to buy methanol for sale in Saudi Arabia or in the Arabs league Countries or in any other area outside Celanese exclusive territories (North and South America and Western Europe)".
3. "Celanese shall undertake the marketing of any remaining quantities of methanol".⁽¹⁾

The marketing agreement as well as marketing fees

(1) SCT Methanol Project Feasibility Study, Volume 5, June 1979.

are negotiable. The methanol which is produced by the two plants Ibn-Sina and Al-Razi is being marketed internationally since 1983 when Saudi Arabia penetrated the world petrochemical market for the first time with a shipment of 33,000 metric tons of methanol from the Al-Razi plant. All the methanol produced is marketed primarily in Western Europe and Japan. Those countries that import methanol utilize it as an input in manufacturing many products such as methyl tertiary butyl ether (MTBE), formaldehyde, acetic acids, detergents, films, industrial solvents, vinyl acetate, pharmaceuticals and anti freezing agents. According to the five year plan 1985-1990 SABIC methanol demand will not exceed 190,000 tons per year for the MTBE project. so the future demand for methanol represents only 14.6 percent of the name-plant capacity of both methanol plants. SABIC markets its methanol share locally and internationally through its affiliates; SABIC Ltd. and SABIC marketing services Ltd. SABIC has distribution centres in Singapore, Indonesia, Hong Kong, Rotterdam, Turkey, and Japan.

9.2 MARKET CONDITIONS

The future demand and supply of petrochemical products are uncertain because of many considerations such as the linkage between the demand side and world economic growth, the price of oil and gas and the

future of situation of the world trade.

Basically, need creates demand and the demand for a produce creates its own supply. The chemical industries' successful marketing relies on a basic fact which is common to all types of marketing; it is to produce goods that people need rather than make product purely for sale.⁽¹⁾ We can see this in the case of medical production. In the same way the need for petrochemical products by countries around the world would create a high demand for petrochemical products.

On the other case, supplying a new product may create its own demand. Actually the success of the petrochemical industry in the last two decades has been mostly due to the supply of new products such as rubber, plastic, synthetic, and detergents. The petrochemicals managed to replace other products which were produced traditionally from non-petroleum resources such as agriculture and other minerals (steel and iron), thus creating a need for these products. The production costs in this industry were reduced and the prices of the end products fell. The main reasons of the decline in prices were the low

(1) Chemistry and Industry, No. 11, 1st June 1974, p. 432.

cost of new raw materials, especially naphtha which cost well under \$20 per ton during the fifties and sixties⁽²⁾, and the second reason was the development of technology which helped in reducing production costs through the establishment of large-scale plants.

Approximately the scale factor by which the cost of a plant may be related to its capacity can be expressed by:

$$S = C^{0.6}$$

S = is the factor of increase in costs.

C = is the factor of increase in capacity.

This would mean that a doubling of the capacity of a proposed plant would only increase its cost by a factor slightly over 1.5. The 'point 6 rule' suggests:

"that capital costs rise at a rate equal to the rate of increase of output raised to the power 0.6, that is more slowly than the rate of increase in output. The "rule" applies largely to those industrial processes where a major item of the capital equipment consists of something which is spherical or cylindrical, for example a kiln, blast furnace, a storage tank, a vat, and so on. The "rule" derives from the simple mathematical relationship between the volume of a sphere or cylinder and its surface area; the cost of equipment of this kind is said to rise roughly in proportion to the surface area, that is to the amount of materials used. This of course applies only up to a certain size when the strength of the cylinder or sphere would be reduced with increasing size unless a thicker wall was used. There is evidence that the point

(2) Chemistry and Industry, 20th November 1976, p.967.

6 rule applies at least to major processes, if not to all equipment, in a number of industries: these include aluminum ingot manufacture, alumina production and aluminum rolling and drawing, cement manufacture, the production of oxygen, the production of synthetic and oil refining, the production of petrochemicals and large ocean-going oil tankers".⁽¹⁾

The basic petrochemical ethylene, propylene, butadiene, and benzene supply increased widely throughout the 1960s because of high economic growth, the growing use of synthetic substitutes for natural resources and the cheapness of oil and gas. The 1973 oil crisis caused severe effects for the petrochemical industry as a whole. A general recession followed the energy crisis in 1973, on the supply side, the higher prices of oil and gas caused the petrochemical production to decline because of the decreased return with the high cost of production. Also it caused a large decline in the demand and a moderate growth rate during the period 1976 to 1980. Even though the growth rate of about 5.5 percent was achieved in the four basic petrochemicals through this period of time.⁽²⁾

The major basic petrochemical ethylene, is one

(1) R. B. Sutcliffe, "Industry and Underdevelopment", 1971, p.201.

(2) Organisation for Economic Cooperation and Development The Petrochemical Industry, (Paris, 1979), p.13.

leading indicator of petrochemical activity. The world ethylene capacity reached 53.9 million metric tons a year, about 7.5 percent was added in 1981 as Table 9.1 show. The Middle East contribution to this figure was only one million tons per year but there was drastic change during 1981 to 1985, the Middle East expects to dominate ethylene capacity, while the contribution of industrial countries would be very slight. Saudi Arabia is expected to produce more than 50 percent of the Middle East capacity.⁽¹⁾

The developing countries share of petrochemical output according to the United Nations Industrial Development Organisation will increase by 1990, achieving over 20 percent of ethylene, 34 percent of fibres, 20 percent of synthetic rubber, and 27 percent of thermoplastic of the total world production. The same UNIDO study expects a large increase in demand for the five principal thermoplastics, from 14.8 billion lb in 1979 to 48 billion lb 1990, an average annual increase of 11.4 percent, as illustrated in Table 9.2.

The demand for petrochemicals in the future is estimated to be very high, because of the continual emergence of new products. For example the

(1) Hydrocarbon Processing, January 1981, p.8.

TABLE 9.1

*Estimated Worldwide Ethylene Capacity
in 1981 and Scheduled New Capacity
Through 1981-85*

(millions of tons per year)

SECTOR	1981	1981-1985
U.S.	16.80	0.46
Canada	1.80	0.0
Latin America	3.80	1.67
Europe	21.80	2.05
Africa	0.50	0.48
Middle East	1.00	3.04
Far East	8.00	3.04
Austria	0.25	0.60
TOTAL	53.95	11.11

Source: "1982 Market Data", Hydrocarbon Processing,
June 1981, p.9.

TABLE 9.2

*UNICO Forecast of Basic
Petrochemical Output by 1990*

(Million of lb)

Petrochemical	TOTAL WORLD		DEVELOPING COUNTRIES			
	1979	1990	1979	1990	Share of Total	
					1979	1990
Ethylene	82.72	154.88	6.01	30.80	7.3	19.0
Propylene	43.34	81.18	2.62	9.83	6.0	12.1
Butadiene	11.00	18.26	0.88	3.52	8.9	19.3
Benzene	37.84	67.76	2.60	11.00	6.9	16.2
Xylenes	13.42	26.18	1.45	6.60	10.8	25.2
Methanol	25.52	60.72	2.64	7.81	10.3	12.9

Source: Chemical and Engineer, July 20, 1981, p.19.

construction industries may consume greater quantities of plastics as a replacement for metals, glass and wood, in the future. The production of plastic in the world in 1970 was about 26 million tons. In 1985 this figure may rise to around 120 million tons as Table 9.3 shows.

9.3 The Main Factors Affecting Petrochemicals Demand

The demand for petrochemical products are determined by three main factors, prices, industrial requirement and the use of product.

9.3.1 Prices:

Two kinds of prices would affect the demand for petrochemical products; namely, petrochemical prices, and the price of substitutes and complements.

In theory, the demand for a product in any type of market, can be determined by the price of this product. Also the prices of other goods would affect the demand for a particular product. The demand for plastic products would decrease if their prices were to increase. Also this would happen if the prices of other goods were to rise. This is because the consumers have limited amount of income and have to balance their spending on different products, starting with necessities such as food, clothes, housing, and so on. If the prices of necessities go up they still

TABLE 9.3

*World Demand for Basic Petrochemical
Products in 1970 and 1985*

(Millions of tonnes)

END PRODUCTS	1970	1985
Plastics	26,275	120,306
Man-made Fibres	8,146	22,033
Rubber	8,756	18,618
Synthetic Detergents	7,918	17,180
INTERMEDIATES		
Vinyl Chloride Monomer		24,625
Styrene Monomer		18,118
Acrylonitrile		5,460
DMT		6,402
TPA		4,079
Caprolactam		4,027
Ethylene Oxide		7,560

Source: UNIDO, First World-Wide Study on the Petrochemical Industry: 1975-2000. UNIDO/ICIS. 83, 12 December 1978, p.226.

have to buy, but not the same quantities as before and at the expense of other goods.

The price of petrochemical products may rise due to the increase of production cost, and the change in quality of the products. The significant jump in prices of petrochemical products after the oil crises of 1973 are shown in Table 9.4. The price of ethylene for example increased from \$90 in 1970 to \$285 in 1974 and to \$330 in 1975 then to \$740 per ton in 1980. This was due to the increase in the cost of raw materials namely naphtha and natural gas which increased from \$16 to \$110 per ton and from \$11 to \$31 per 1000 cubic metres respectively in the same period. All other prices in the table also increased in different ranges.

9.3.2 INDUSTRIAL REQUIREMENTS

The petrochemical products are widely used in different industries as raw materials as well as in some industrial processes. This is the main reason which have accelerated this industries growth for the past thirty years.

The demand of petrochemical products in the developed countries is always higher than that in the developing world. The automobile industries in the industrial world reduce the weight of cars to save

TABLE 9.4

TRENDS OF EXPORT PRICES FOR SPECIFIC CHEMICAL PRODUCTS, OIL
NAPHTHA AND GAS 1970-80 (US DOLLARS PER TON)

PRODUCT	1970	1972	1974	1975	1976	1977	1978	1979	1980
Ethylene	70-90	80-90	260-285	260-330	240-330	295-315	286-370	310-590	410-740
Propylene	45-90	50-90	185-220	185-200	185-220	185-200	200-230	370-410	400-420
Ammonia	35-90	38-45	135-150	150-230	105-123	100-120	95-110	120-160	140-200
Methanol	60-90	50-70	100-250	100-150	100-130	90-135	120-130	150-175	200-240
Acrylonitrile	250-270	250-270	590-660	490-550	480-550	450-560	540-590	590-860	680-750
Glycol	100-190	100-170	340-450	430-470	340-440	330-395	330-340	550-700	600-800
Benzene	58-65	60-65	315-350	250-300	230-280	200-240	245-255	490-560	490-560
High-Density Polyethylene	290-370	270-340	700-790	615-660	620-680	200-240	245-255	490-560	490-560
Low-Density Polyvinyl Chloride	230-300	250-300	680-740	550-600	550-600	500-560	515-560	840-950	980-1150
Oil ^a	290-330	220-380	650-760	510-570	520-610	510-580	580-700	840-950	870-1100
Naphtha ^b	13.31	18.19	85.41	85.01	91.25	100.72	100.72	102.80	
Natural gas ^c	16.08	20.02	123.25	109.73	130.69	125.12	146.14		
(for 000 m ³)	11.05	12.33	20.12	31.02	36.05	47.02	57.20	66.57	102 ^d
	9.37	10.81	18.31	39.20	60.39	64.80	76.79	87.16	156

^a Persian Gulf, Arabian light (Ras Tammura) 34.0 - 34-09^b APN. 1970-1978 Platt's Oil Price Handbook and Oil Manual form 1979, Platt's Oilgram Price Report.

^b European Bulk, Italy.

^c Export prices of Netherlands and Canada.

^d Preliminary figures.

Source: UNICO, "Second world-wide study on the Petrochemical Industry: Process of Restructuring", Istanbul, Turkey, 22-25 June 1981, UN, 1981, P.84.

energy because of the high prices of oil. This weight reduction will increase the demand for plastic and petrochemical products from about 7 percent to 20 percent in creating vehicles. In 1974 87.01 percent of the world total petrochemical products were consumed by the industrial world (West Europe, Eastern Europe, North America and Japan). Asia excluding China and Japan was in second place consuming 5.08 percent, followed by Latin America with 4.71 percent and Africa by only 1.81 percent as illustrated in Table 9.5.

The limited demand for petrochemical products in the developing world are caused by the low standard of living and the small markets for petrochemical products. Also the demand of these products depends on other factors such as the size of population, consumer taste and preference particularly for new products. But the future demand for petrochemical products will continue to increase while the developing countries seeks to industrialise. In the mean time more petrochemical end-products are demanded in the developed countries than in the developing countries.

9.3.3 Use of Product

The use of product can be determined by the geographical area of demand; in agricultural areas the

TABLE 9.5

World Consumption of Major Petrochemical
End Projects

REGIONS OF THE WORLD	1974
Western Europe	31.61
Eastern Europe	11.91
North America	31.68
Latin America	4.71
Africa	1.81
North Africa	0.54
West Africa	0.29
East Africa	0.28
Central Africa	0.14
South Africa	0.55
Asia excluding China	16.89
Middle East	1.01
East Asia excluding Japan	1.40
Japan	11.81
South Asia	2.27
Pacific	1.39
TOTAL WORLD	100.00

Source: UNIDO, First World-Wide study on the Petrochemical Industry: 1975-2000. UNIDO/ICIS, 12 December 1978, p.64.

demand for petrochemical fertilizers are much greater than in non-agricultural areas. This is because fertilizers are used only for agriculture and the demand for this product would depend on the future of agriculture in the country. On the other hand plastics would surely be demanded in any country whether it is agricultural or not, because agricultural countries can use plastic products, in many ways such as water schemes, draining, plastic houses, so on, and they need plastic products as much as the industrial countries.

According to the first United Nations International Conference on the development of petrochemical industries in developing countries:

"It is (the petrochemical industry) a dynamic industry which supplies intermediate products to a number of other industries and also provides substitutes for traditional materials, such as steel, rubber, paper, natural fibres, soaps etc.. This industry is regarded as strategic to the inducement of future industrial development because most of its output goes to other producing sectors".⁽¹⁾

(1) Report of the First United Nations Interregional Conference on the Development of Petrochemical Industries in Developing Countries, Teheran - Iran, 16-30 November 1964, United Nations, New York, 1966, pg. 1 and 9.

The demand for the petrochemical products are high for both the basic products and end-products depending on the type of market and use of the products in a country. The basic petrochemicals may be demanded in higher quantities by the industrial market than that of the construction market which would demand end-products. Both markets may use plastic products, because the use of plastics are unlimited in construction market, industrial market or other daily uses in factories, housing, schools, etc.

9.4 Access to the World Markets

Access to the world market for Saudi petrochemical products would involve some difficulties, because of the following facts:

1. The industrial countries may impose some protectionist measures against Saudi petrochemical products. Europe, for instance impose 12-13 percent custom duties Saudi products were required to pay for entry to European Community ⁽¹⁾. Only a minute amount of Saudi methanol enters the European market duty-free. It is true that the Common Market

(1) Caroline Montagu Industrial Development in Saudi Arabia 1987, p.81.

Generalised System of Preference (GSP) gives duty-free access to the developing countries' products to the EEC market. Under the GSP Saudi Arabia was permitted to export only 2,461 tons of methanol to Europe Free of tariffs in 1985, and 25,385 tons in 1986.⁽¹⁾

The escape clause which is the most important safeguard instrument in the GSP reveals the main motivation behind European protectionist policies. Europeans justified the imposition of a tariff on Saudi methanol, because they believe that free access to the European market is expected to cause damage to the European home industry. Therefore, the EEC classified methanol as a sensitive product which makes it subject to the imposition of a tariff.

Products are called sensitive if the European producers face tough competition from the foreign producers. The president of CEFIC (the Council of Chemical Manufacturers Federation) said "We are in favour of free trade. We are

(1) GSP was introduced to GATT by Europeans after the UNCTAD at New Delhi in 1969. It was not implemented by ECC until 1981. In 1981 it was renewed for another ten years. There are more than 126 nations considered beneficiaries of GSP scheme. See European Trade 1985, p.233.

in favour of non-protectionism. But if we open our door in isolation, we lose competitiveness. That is the problem"⁽¹⁾.

The view existing in Europe is that:

"Since 1969 when GSP was introduced, these countries have progressed from a developing status to strong industrial powers. It seems illogical to allow in duty-free imports made from cheap raw materials, especially when the European industry is suffering from massive overcapacity"⁽²⁾

The other point of view calls for such protectionist measures being imposed on petrochemical imports from Saudi Arabia and other Arabian Gulf countries, but emphasises the principle of give and take. "Europe cannot just demand oil from the GCC and then close the door on their petrochemicals"⁽³⁾

However if the oil glut situation persists throughout the 1980s because of the increase of oil production from non-OPEC countries, then the importance of GCC countries as suppliers of oil to Europe and other industrial countries will shrink, and those who adopt the principle of give and take will have little or no ground

(1) Chemical and Engineering News. November 25, 1985, p.21.

(2) S. Milmo, "How Do European Chemical Producers Spell 'Anxiety'? A.R.A.B.S" Chemical Business, March 8th, 1982, p.14.

(3) S. Milmo "How Do European" p.11

from which to defend it and the GCC countries may face an eventual weakening of their bargaining power.

2. The second factor that discourages Europeans from exempting the Saudi petrochemical products from tariffs lies in European commitments to honour the Maghreb agreement and the Trade Compensation agreement. The Maghreb agreement was signed in April 1976, between Morocco, Algeria and Tunisia on one hand and the EEC on the other. This agreement allows the three countries to export petrochemical products to Europe duty-free, and the second agreement leads to further saturation of petrochemical in Western Europe. The Compensation Trade agreement is a sophisticated form of barter economy. Western European chemical producers in the late 1970s, financed the construction of several petrochemical plants in Eastern Europe. Those who supplied the capital investment would be entitled to a certain percentage of the petrochemical plants output. So these agreements restrained the ability of European countries to eliminate tariffs on Saudi petrochemicals while encouraging foreign exports to Europe.

3. The traditional producers of petrochemicals have been in the market providing their traditional consumers with their needs of petrochemical product for many years, and it is not easy for them to give up portions of their traditional markets. These producers realised that with the increases in feedstock and energy prices, variable costs have become increasingly important for their basic petrochemicals, and that Saudi petrochemicals producers with cheaper and closer access to feedstock are potential competitors. So they will impose great political pressure to restrict Saudi petrochemical products from entering the world market.
4. The foreign joint-venture partners already agree to market 70 percent of the output of petrochemical products. But this is subject to some limitations. Although world petrochemicals are expected to pick up with the world recovery from economic recession, but the degree of recovery will differ from one product to another, and the marketing of 70 percent of production by the foreign partner's may face difficulties for those products experiencing a slow recovery.

The joint-venture partners have to close out or reduce the capacity of some of their plants in order

to be able to absorb the assigned Saudi Petrochemicals produced in their joint-venture plant in Saudi Arabia.

The Japanese Minister of International Trade, Masumi Esaki, declared that the joint venture with Saudi Arabia will continue even if two or three plants go into bankruptcy because of economic factors.⁽¹⁾ The Vice-Chairman of SABIC explained that "our partners recognised that some of their plants which were either too small or insufficiently up-to-date from the technical point of view will have to be shut down"⁽²⁾. The greater the losses resulting from such procedures, the slower the degree of adoption of more and more Saudi petrochemicals.

5. The petrochemicals of Saudi Arabia are state owned at this stage and expected to make profits with no export subsidy or protection from competing petrochemicals in the region. Exporting to markets of the developing countries has to be carefully studied. Some of these countries are having serious financial problems. The developing countries may move to buy Saudi petrochemicals with a great expectation

(1) Chemical Week November 5th 1980, p.43.

(2) Hugh George Hambleton, The Saudi Petrochemical Industry in the 1980s, p.39

that at least some of these sales agreement will be part of the Saudi extended aid program. However, a distinctions must be provided, and the Saudi government should pay their petrochemical agencies promptly for petrochemical aid extended to the developing countries. So the result is that the developing countries markets might not be able to provide boundless hope for future Saudi petrochemicals.

9.5 The GCC Industrial Cooperation

The main reason for the Saudi establishment of the petrochemical industry was the diversification of the Saudi income, but the access to the world market could be a real problem that may affect the Saudi future. If this petrochemical industry does not generate profits and continues to receive subsidies from the government, it will be an economic burden. So the marketing problems must be solved by other alternatives.

Expanding the marketing for Saudi petrochemicals is possible through further regional cooperation. Joint efforts would introduce greater international bargaining power in solving the marketing problems. The only form of cooperation in the Middle East is the Gulf Cooperation Council (GCC), between the six Arab Gulf countries, Saudi Arabia, Bahrain, Kuwait, Qater,

Oman, and the United Arab Emirates. The main objective of the GCC is to establish a Gulf cooperative identity on economical, political, and security matters.

The GCC countries share many similarities in their economic, social and political characteristics. They have common heritage, they speak the same language (Arabic), same religion (Islam), similar political interests, both regional and international and social system. The economic characteristics of the GCC countries are the following:

1. The economies of the GCC countries are similar, oil is the main source of foreign exchange and government revenues. Oil represents more than 90 percent of both export earnings and government revenues, and contributes more than 60 percent to the GDP of all GCC countries.
2. The per capita incomes in some of the GCC countries like Qatar and the United Arab Emirates (UAE) are among the highest in the world, because of the small population and high oil revenues. But this fact does not change the image of the region and its people as part of the third world sector, and it does not reflect highly developed economies, unless it is accompanied in the future

with real economic growth in all sectors and structural change.

3. The GCC countries, with the exception of Bahrain and Oman are a capital surplus one. After the oil price increases in 1973 and 1979, Saudi Arabia, Kuwait and UAE accumulated a great deal of oil wealth. The major local government expenditures have created much economic imbalance and high inflation rates, especially in the period 1974-1978, because of the limited absorptive capacity. These surpluses have started to diminish as GCC economies began to absorb more capital as a result of the relative easing of the existing bottlenecks. Also, the revenues from oil export declined, because of the downward on both prices and production of oil.
4. The governments of the GCC countries control and reallocate oil revenues through current and expected developmental expenditures. They play an important role and carry major responsibility in the process of domestic development. Most of the development projects, including industrial projects are state-owned. These governments' policy is to run these projects to the point where they are profitable, at which point the governments share is sold to the public. Even

with the increasing importance of the private sector's role, the governments of the GCC countries believe that some projects ought to be established by the governments. This is because of the following :

- a. The large amount of capital involved.
- b. The lengthy period of investment required before making any profit.
- c. The lack of industrial background among most private investors.
- d. Public utility and infrastructure projects do not attract private investors, since the investors' main motive is a high money return and less social return.

5. Prior to the 1970s, agriculture had been the dominant sector in some of the GCC countries such as Oman. But now this is not the case. The agriculture sector contributes not more than 1 percent to the GDP of the GCC countries. The main reason for the low productivity of the agriculture sector is the lack of water, limited arable land and the continuous flow of agricultural workers to other sectors of the economy.

6. Foreign population represents more than one-third

of the total population, and in some countries like Kuwait, the UAE and Qater, the foreigners represent more than one-half of the total population. Most of the foreign population had entered the area in the 1970s in the response to the increasing demand for labour by the development of projects in the region. But since the early 1980s, the growth rate of the foreign population slow down, because most of the construction jobs are done, and more foreigners are replaced by nationals.

7. The foreign trade sector is the main component in the GCC countries. Imports of these countries increased starting in 1974 when the earnings from oil exports increased. These countries import most of their consumer and capital goods. The average propensity to import increased between 1974 and 1982; however the marginal propensity to import started to level off because of the slow downs of government expenditures, also the better public understanding about more saving and less consumption being desirable.
8. There is no geographic separation between the GCC countries, and the region has access to two bodies of water, the Red Sea and the Arabian Gulf. The total land area of the region is

2,490,590 square kilometres.

9. The GCC countries have limited natural resources other than oil and natural gas. Minerals are said to exist in some of these countries, such as Saudi Arabia, but limited in quantity and no major production process has been established yet.
10. The shortage of domestic manpower is a common economic constraint among the GCC countries. The number of foreign workers has significantly increased in these countries since 1970s, and this started to create social problems. It is argued that if the social costs of those expatriates are added to their wages, that they might in some cases exceed their contributions to the GDP.⁽¹⁾

9.5.1 The GCC Industrial Integration:

The similarities in the economic of the GCC countries creates a strong incentive toward comprehensive cooperative policy of industrialisation

(1) R. Hablulzel "Issues in Economic Diversification for the Oil-Rich Countries" Finance and Development, June 1981, p.12.

or what is known as industrial integration to achieve the development of the region's industries to reduce dependency on oil as the main source of income. But before discussing the GCC industrial integration, it is appropriate to give some background about economic integration.

9.5.2 The Definition of Economic Integration:

The term "integration" is defined as bringing together of parts into a whole. But the term "economic integration" in the economic literature does not have a clear-cut meaning. At one extreme the term means the existence of trade relations between independent national economies; another meaning is the complete unification of national economies. In economic theory, the concept of integration is related to the criteria of factor, production, and social mobility.

Some economists contend that economic integration does not only result in the elimination of discrimination between economic units that belong to different national states, but also result in the introduction of coordination and harmony which ensure the optimal development of the economy as a whole. In countries within the integrated region the economic integration is the achievement of optimum reallocation of resources through interdependent

economic relations among these countries. The removal of tariffs considered by most economists as the basic means of achieving this economic goal. According to J. Tinbergen,⁽¹⁾ economic integration is:

"The creation of the most desirable structure of international economy, removing artificial hindrances to the optimal operation and introducing deliberately all desirable elements of coordination or unification".

There are two common features to economic integration:

1. Economic integration facilitates trade exchange and specialization in production in an enlarged market area.
2. Economic integration discriminates against the outside world.

According to G. Myrdahl⁽²⁾ economic integration is a process of social transformation centering around the ideal of equality of opportunity, unless all avenues are open to everybody and the remuneration

(1) J. Tinbergen, International Economic Integration (Amsterdam: Elsevier, 1954), p. 95.

(2) Gunnar Myrdahl, An International Economy (New York: Harper and Row, 1956), p.11.

paid for productive services are equal the economy is not integrated. But this approach by Myrdahl is general and did not provide a complete interpretation of economic integration.

An acceptable definition of economic integration was given by Bela Balassa.⁽¹⁾ He defined it as "the abolition of discrimination between economic units belonging to different national states".

The process of this abolition of discrimination have the following stages:

1. A free trade area is created where members of the integration scheme achieve a complete removal of tariffs among themselves.
2. Customs unions develop, where a common tariff for the countries within the area is placed against outsiders.
3. A common market is developed, where factor movements are freed within the area.
4. An economic union is created wherein, to some degree, the differing fiscal, monetary, and social policies of the countries within the union move in the same direction.

(1) Bela Balassa "Towards a Theory of Economic Integration" Kyklos, 14, No. 3 (1961) p.3.

5. A supranational union, wherein supranational authority issues binding decisions over different economic policies is created.⁽¹⁾

One criticism of Balassa's interpretation of economic integration is that it did not go beyond static market situation in interpreting the process of integration.

9.5.3 History of Economic Integration

In the 19th Century the first important case of economic integration was the German Zollverein, which led to total economic integration through the unification of the German states with the establishment of the Deutsches Reich. In the 20th Century, the creation of the Benelux customs (1948) and subsequently economic union in 1949, comprising Belgium, Luxembourg, and the Netherlands, represented the first step towards European economic integration.

In 1953 the European Coal and Steel Community was established. It was followed in 1958 by the European Economic Community (EEC), both comprising Belgium, France, Italy, Luxembourg the Netherlands and West Germany.

(1) Bela Balassa "Towards a Theory of" p.15

In 1960, Austria, Denmark, Norway, Portugal, Sweden, Switzerland and the United Kingdom founded the European Free Trade Association (EFTA). Finland participated first as an associate, but later as a full member. In 1968 the United Kingdom and Denmark left the EFTA and together with Ireland entered the EEC. In 1978 Greece became a member of the EEC and Portugal and Spain joined the EEC in 1986.

In 1948, in Eastern Europe, the Council for Mutual Economic Assistance (CMEA), was established, with the participation of the Soviet Union, Bulgaria, Czechoslovakia, Hungary, Poland, and Rumania. Albania, East Germany, Mongolia and Cuba became members of the CMEA.

The developing countries have been attempting a number of economic integration. In 1960 the Latin American Free Trade Association (LAFTA) was established, comprising Argentina, Bolivia, Brazil, Chile, Columbia, Ecuador, Mexico, Peru, Uruguay and Venezuela. The LAFTA was established for a free trade among the members. Other attempts were designed to become customs Unions, such as the West African Customs Union (1959), between the Ivory Coast, Mali, Mauritania, Niger, Senegal, and Upper Volta. In 1960, the Central American Common Market was established between Costa Rico, Guatemala, Honduras, Nicaragua, El

Salvador. In 1967 the East African Economic Community including Tanzania, Kenya and Uganda was designed to become an economic union.⁽¹⁾

In 1945 the Arab League was established among the Arab World. In 1964 the Arab Economic Unity (AEU) comprising Egypt, Syria, Iraq, Jordan, and Kuwait. Moraco signed, but did not ratify the agreement. In the second half of 1964 the Arab Common Market (ACM) was ratified by only four members Egypt, Iraq, Jordan and Syria. In 1974 the ACM was to begin promoting trade liberalisation to be accomplished within five years for agricultural products and within ten years for industrial products.⁽²⁾

9.5.4 Customs Unions and Economic Integration:

The Customs Unions Issue by J. Viner ⁽³⁾ in 1950, was the first important contribution to the theory of economic integration. Viner distinguished between the "trade-creating" and the "trade diverting" effects on union and investigated the impact of customs unions on trade flows.

(1) The New Palgrave a dictionary of economics. Edited by John Eatwell, M. Milgate and P. Newman 1987.

(2) A. El-Ghandour "Economic Cooperation and Integration Efforts in Selected Countries of Western Asia", (New York: United Nations 1975), p.33.

(3) Jacob Viner The Customs Union Issue (London: Carnegle Endowment for International Peace, 1950).

Trade creation is the shift from domestic to partner country sources of supply of a particular commodity. It increases economic welfare in as much as higher-cost domestic source of supply are replaced by lower-cost imports from partner countries that were previously excluded by the tariff. In the other hand trade diversion has a welfare cost since tariff discrimination against non member countries attendant on the customs union, lead to the replacement of lower-cost source of supply by higher-cost.

The establishment of customs union affects the prices of goods in the domestic market. It also affects the trade flows, production, and consumption through its impact on:

1. The allocation of resources and international specialisation.
2. The exploitation of scale economies.
3. The terms of trade.
4. The productivity of factors.
5. The rate of economic growth.
6. The economic stability.
7. The distribution of income⁽¹⁾.

(1) Peter Robson The Economics of International Integration (London: G. Allen and Unwin, 1980), p.11).

The net welfare effects of the customs union according to Viner will depend on the amount of trade created and diverted as well as differences on unit costs. He has certain assumptions about the issue of the customs unions that held true through his analysis. These assumptions were:

1. pure competition in the commodity and factor market;
2. comparative static analysis;
3. resources are fully employed;
4. production opportunity costs are accurately reflected by prices;
5. fixed transportations costs.

Viner's conclusion was that a trade-creating customs union will benefit at least one member and the world at large, where as the trade-diverting is harmful to at least one member and the world at large.

The effects of a customs union on intercommodity substitution, involve the replacement of domestic products by partner country products, and the replacement of products of non-member countries by partner country products. As in the case of substitution among the sources of supply of a product, trade creation involves a welfare improvement, and trade diversion the deterioration of welfare, in the event of substitution among commodities were

considered by J. Meade⁽¹⁾. He indicates that in evaluating a customs union, whether there is a loss or net benefit as a result of its creation, consideration should be given not only to the trade volume on which the costs have been lowered, but it should be given also to the extent to which costs have been increased or decreased on each unit of created or diverted trade.

Lipsey and Lancaster⁽²⁾ argued that free trade will lead to efficient resource allocation assuming that Pareto optimum conditions are fulfilled, but pre-union as well as the post-union situation are sub-optimal, because tariffs exist in both cases. So one cannot say whether establishing a customs union will increase or decrease welfare.

Lipsey⁽³⁾ suggested that the customs union welfare effects will depend on the relative importance in the home consumption of goods produced in the domestic market and imported from the non-member countries before the establishment of the union. The larger the share of the domestic goods and the smaller

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- (1) J. E. Meade, The Theory of Customs Union (Amsterdam: North Holland), 1955, p.35.
 - (2) R. G. Lipsey and K. J. Lancaster "The General Theory of Second Best" Review of Economic Studies, 24, 1956 pp.11-32.
 - (3) R. G. Lipsey, "The Theory of Customs Unions: a general Survey" Economic Journal, 70, 1960, pp.496-513.

the share of goods imported from the non-member countries, the greater the improvement in welfare following the union establishment. This will be the case since substitution of partner countries product for domestic products entails trade creation for the non members products.

9.5.5 The Developing Countries Economic Integration

The developing countries seek important benefits through integration arising from the exploitation of economies of scale. When the economy passes the subsistence stage, it will look for export expansion or import substitution as the main engine for the proposed growth.

The final Act of the first United Nations Conference on Trade and Development (UNCTAD) held in Geneva in 1964 stated the following:

"Regional economic groupings, integration or other forms of economic cooperation should be promoted among developing countries as a means of expanding their intraregional trade and encouraging their economic growth and their industrial and agricultural diversification with due regard to the special features of development of the various countries concerned as well as their economic and social system".⁽¹⁾

(1) United Nations Conference on Trade and Development "Final Act and Report" Vol. 1 of proceedings (New York: UNCTAD) 1964, p.11.

The essential need for developing countries is for production cooperation among these countries. The domestic markets of most of these countries are so small, the manufacturer of many products for the domestic market alone is not practical, even with the existence of high tariffs on imports. Also, trying to enter the international market for manufactured products will be difficult and involve unexpected disappointment, especially at the early stage of a new industry.

The developing countries through integration their regional market will be greater in size than each country's domestic market, and the marketing difficulties experienced with the manufactured goods will decline. The economic integration would create an opportunity to increase a profitable domestic as well as foreign investment. The small nation economic structure is less diversified than that of larger nation and therefore the production will be in fewer sectors. This can be explained as follows:

1. Smaller nations usually have smaller territories than larger nations, and the diversity of national resources is a function of the area size.
2. Some modern industries' minimum scale plant can be

sustained by the economy of a small country only at a loss or on the basis of assured foreign markets.

3. A large country can divide its large volume of resources among greater numbers of sectors with comparative advantage.⁽¹⁾

The possible success of integration schemes in developing countries will depend on both harmonisation of their investment and production programmes as well as on trade liberalisation, so to benefit from economies of scale and from the complementarity of their factor endowments in an enlarged market. The experience of the developing countries in economic integration has been characterised with limited success, because of the special political, economic and social nature of these countries.

9.5.6 Lessons to be Learned by GCC Countries

The GCC countries should learn from the developing countries to be aware of possible problems that can be avoided. Some of these problems can be eliminated, and other problems can only be minimised. The following lessons could be followed by the GCC

(1) Simon Kuznets Six Lectures on Economic Growth (Glencoe, New York: Free Press, 1959), p.92.

countries, but there is no assurance that they will be successful. These lessons can be explained as follows:

1. All members should take a long-term view with regard to benefits from the scheme and should realise that static gains from integration within a short period are only a small part of the whole long-term gains.
2. The scheme should take into account that the gap among members in their wealth and development level will be eliminated over time.
3. The members of the scheme are to plan for fair distribution of benefits with respect to regional investment and its distribution, as an example the selection of new regional industries and locating these industries.
4. The members are to accept regional planning and to surrender sovereignty to the extent of allowing the application of such decisions.
5. The need for functioning specific arrangements that set goals and methods of achieving them. Generalisation of schemes specific objectives would cause many delays and inconsistent

practices.

6. Harmonisation of the national policies within a regional framework is a step essential for avoiding conflict of interests.
7. As much as possible decisions for pooling demand and resources within the scheme should be judged from an economic point of view with respect to an expected higher level of efficiency rather than from expected political influence.
8. Trade liberization should not be made the bulk and substance of the scheme. The special economic bottlenecks of the developing countries cannot be solved through market mechanisms alone, but rather they must be coupled with coordinated production policies by emphasising regional solutions and by reducing redundancy in bureaucracy.

9.5.7. The GCC Countries Background:

Now we come back to the GCC countries' industrial integration. In 1981 the GCC was established, including Saudi Arabia, Bahrain, Kuwait, Qatar, Oman and the United Arab Emirates as members.

The GCC industrial integration is the major

element of cooperation since it deals with the present and future bath of the region economic diversification.

The United National Industrial Development Organisation (UNIDO) has set up general conditions for industrialisation.

1. The countries involved must be at similar stage of development.
2. The raw materials must be available.
3. The production of the commodity to be manufactured must be profitable within region.
4. The transportation costs of the commodity and its input must be low relative to the value added in production. (1)

The cost-benefit balance of industrial integration will depend on the market size, factor endowment, access to international markets, geographical location, and the level of policy coordination within the region. Also it will depend on how effective the integration scheme is in reducing types of dependency on the outside world. These dependencies are:

(1) United Nations Industrial Development Organisation, Industry and Development, No. 1 (Vienna: United Nations, 1979) p.1

1. the market dependence that includes the concentration of exports of most developing countries in one or a few primary products and in one or a few markets.
2. The technological dependence which refers to the transfer of technology to those developing countries, because they lack capital goods industries, which are the main vehicles for local innovation.
3. The dependence on managerial and skilled workers.
4. The dependence on foreign capital⁽¹⁾.

Industrial integration amongst these countries would prevent duplication of industries, also would allocate resources more efficiently. However most of the industrialized world opposes industrial integration. This opposition is understandable to the extent that their economies are relatively more sophisticated with respect to production, market factors and government intervention.

The GCC countries should consider the following industrial strategy:

(1) M. Roemer, "Dependence and Industrialisation Strategies", World Development, 9, No. 5 (1981) p.429.

1. The GCC countries should give a greater emphasis to the nature of member countries' factor endowments. Since these countries endowed with more capital than labour, they should favour capital-intensive industries over labour-intensive industries.
2. The GCC countries' similarities in their natural resources and that they are adjacent to each other may give some economic foundation to locating their joint projects in Bahrain and Oman at earlier stages since they are the least rich countries. However, after that period the strategy should be to maintain a more equitable geographical distribution of projects.
3. The fact that the GCC market is small in size and in number of population is important. In order to plan import substitution industries the market size should be the principle to determine the projects. Some import substitution joint industries are drugs, housing, electrical equipment, and building materials. The judgement of the viability of these projects should be based on their economic efficiency, costs, and sales prospects.

4. The private sector role should be emphasized. The role of the government holding of different industries in the region should be minimised by selling the government share to the public as applied by SABIC (Saudi Arabia Basic Industries Corporation). This would not only increase the private sector participation in basic industries but also it will give these industries a Gulf identity that would inforce the GCC industrial integration.
5. It is important to maintain balance between unlimited GCC industrialisation and social, and cultural values in such a way that the negative impact of rapid modernization on these values would be minimized.
6. The GCC countries should encourage the merger of existing industrial firms, to include both those that produce the same product and if possible producers of integrated products. The industries concentration is the main feature of today's world industrialisation. The large concentrated industries generally stand firm and face fewer bankruptcy than smaller industrial firms in a recession.⁽¹⁾

(1) R. Williams "Reindustrialisation: Past and Present", Technology Review, 85, No. 8 (November - December 1982), p.56.

9.5.8 Possible Measures for Expanding Access to World Market:

The joint GCC strategy for minimising marketing problems can be described as follow:

1. The GCC countries should establish a joint marketing group that would assist in exchanging information on production and world prices, plus coordinates and plan for petrochemical sales. Also this jointly financed group can also provide the industry with marketing research and similar services, to be offered by the producers of different petrochemical products. The GCC countries should establish communication with traditional producers of world petrochemicals in cooperating and coordinating efforts that might result in future specialisation of market areas by two parties.
2. The policies designed to promote the domestication of foreign technology can be expanded and can be expected to have important impact on the GCC countries' development. For instance the redirection of the subsidies in favour of research and development programs even without an increase in the absolute level of subsidy in the economy would be of great help to the petrochemical producers. These programs will

enable the producers to innovate, improve existing technology and upgrade product quality. The large petrochemical company SABIC establish the research and development program recently in 1990 which can be considered a very late decision, and it should of been established a long time ago.

3. The GCC countries should consider investing in integrated marketing facilities, such as building their own chemical tankers and establishing storage facilities in different market regions. The Saudi has attempted this strategy on its own. SABIC company has commissioned a Japanese company Mitsui O S K, Lines Ltd, to construct a 35,000 ton tanker to be used exclusively for imports. Another 100,000 kl and 5,000 kl tankers have been built by both Japan and Singapore. SABIC also signed a long-term tanker lease contract with GATX Singapore to market 200,000 tones per year of Saudi methanol in the South East Asian market.⁽¹⁾

4. The GCC countries could increase their stake in Western chemical companies. Some GCC countries

(1) "Distribution Base for Saudi Arabian Methanol", Chemical Economic and Engineering Review, October 1982, p.33

have already engaged in buying equity shares in some of the well known companies. Through the purchasing equity shares in the international chemical companies, or by forming joint ventures abroad, GCC countries would make it possible to sell a portion of their basic competitive petrochemicals to those companies as feedstock for their intermediate and final products.

5. The GCC countries extend aid to the developing countries. The average share of the GCC economic aid to these countries has been 6 percent to 7 percent of their GNP. In some cases part of the extended aid has been used to buy fertilisers and other petrochemical products from the international markets. The GCC countries could alternatively provide the aid of these countries by providing their needs for petrochemical products. However, the GCC governments should not involve their petrochemical producers in these aid agreements and should pay the value of the petrochemical aid to these producers as if they were sold internationally.

6. The Arab world market is of a larger size than the GCC market and provides a potential marketing area for the GCC petrochemical products. The GCC could benefit of integration into comprehensive

Arab Cooperative effort is not only from enlarging the market size for their petrochemical products, but also from cooperation with other Arab petrochemical producers, such as the North African Arabian Countries. These countries have been in the markets of petrochemicals long before the GCC entry, and have gained some marketing experience from which GCC could benefit.

7. In case the GCC petrochemicals face trade barriers in any industrialised countries, then GCC countries could (though not preferably) exert some political and financial power to insure fair treatment. These countries may tie oil contracts to the purchase of their petrochemicals. This depends on the international importance of GCC oil.

CHAPTER 10

SUMMARY AND CONCLUSIONS

This thesis started by dealing with the theoretical background of the development planning. Various sources of energy literature have been reviewed, describing the role that hydrocarbon resource exploitation played in the Saudi development plans.

The economy of Saudi Arabia is an oil-based economy where the oil sector is the main source of foreign exchange earnings, government revenues, and a source of growth of the national income. The country has enjoyed a period of high income and high growth during the 1970s as a result of the increase in oil production and oil prices.

Since the oil is the major source of income and since it is nonrenewable resource, the national utilisation of this resource for the ultimate goal of creating a self-sustained economy which can replace this dependence on oil in the future becomes very eminent and development planning is considered the best way to do that.

The petrochemical industry is chosen as the most promising option which could lead to integrating the

oil sector with the rest of the economy. Saudi Arabia selected a large-scale petrochemical industry as capital and energy intensive to exploit its comparative advantage over many other countries in capital and raw materials. Also Saudi Arabia has other advantages over the developed countries which dominate the world petrochemical industry such as the location factor in terms of plant site close to input resources and the lower impact of the petrochemical industry on the environment.

Saudi Arabia suffers from the shortage in skilled, semi-skilled labour, entrepreneurs, administrators, and technology. Petrochemical marketing is another problem due to the surplus in the world market and the general pessimism toward the future growth of demand for petrochemical products.

The government of Saudi Arabia secured the marketing problem by joint-venture policy with well known petrochemical companies which have other plants all over the world. These international companies will be responsible for marketing about 50-70 percent of the total joint venture products at world prices. The labour shortage constraint is a short-run problem and expected to be eliminated in the long run, by the huge expansion of human resources investment, the Saudi labourers will fill the shortage gap. Also,

building recreational facilities to attract foreign labour , increasing productivity of domestic labourers and utilise more female labour force, are very critical factors of the Fourth Development Plan.

Since the petrochemical industry is export oriented, joint GCC countries marketing efforts are expected to overcome some of the difficulties foreseen for entry into the world market. Also to minimize the costs of petrochemical exports, the cost of tariffs and the cost of shipments can be reduced by marketing the products to the nearby nations, exporting to tariff-free nations, and embarking further downstream investments in the related chemical products.

A cost-benefit analysis was conducted to show the international competitiveness of the Saudi petrochemical industry. The findings of this study support the hypothesis that the Saudi petrochemical industry will be competitive and the long-run profitability became relevant.

SABIC and its foreign partners are aware that they will enter the world petrochemicals not to offset a shortage in the world supply. They assume a competitive petrochemical industry without trade barriers where the inefficient plant should be out of the market at lower competitive prices. The old

petrochemical plants in the developed countries would go out of business because of the Saudi competition, but the qualified industries will continue.

Up to the 1970s, the industrial sector in Saudi Arabia was underdeveloped. Although the largest contribution has been provided by the crude oil sector, the role of this sector was mainly fiscal as demonstrated by heavy dependence of the economy on oil revenue. These revenues have been the only source of finance for government consumption, foreign exchange, imports, and investment capital. The majority of the labour employed by the oil sector were foreign nationals earning wages well above the average. Unless serious attempts are made to create a sufficient pool of skilled labour, the country will continue to depend on foreign labour, this situation leads to higher production costs. It is recommended however that for the petrochemical industry the country would have a better chance of creating an efficient training programme with the assistance of both the industry and its foreign skilled workers.

The emergence of oil as a dominant sector in the Saudi developing economy has changed the economy from the status of capital shortage and stagnation to a stage of capital surplus and economic abundance. Realising the vulnerability of overdependence on oil

as the major source of national income, in the early 1970s the Saudi government decided to embark on development programs aiming first to diversify the national economy. The Saudi development plans were faced with problems such as the limited supply of cooperant factors like skilled and semi-skilled labour, technology, administrators, entrepreneurs, arable land, limited water supply, etc. This inadequate supply of such supporting factors has limited the absorptive capacity of the Saudi economy.

The availability of capital is a necessary but insufficient condition for achieving sustainable economic development. Other factors of production are also critical in the drive to achieve and sustain an economic productive base within the country such as human resources, natural resources, and technology.

This thesis considered various procedural approaches for evaluating development projects in order to increase the effectiveness of the development programs in Saudi Arabia, this includes: improving the people's welfare, increasing national income, expanding the country's absorptive capacity and shifting a renewable resource base.

Saudi Arabia invests heavily in large scale - heavy industries such as the petrochemical industry

without incurring the problem of foreign exchange shortages, also the rapid increase in the prices of petrochemical products which most developing countries import from developed countries encouraged the developing countries such as Saudi Arabia to develop their own industries. They believe that a successful petrochemical projects could be achieved, because the many cost advantages which would enable the Saudi petrochemical products to compete in the world market. The availability and cheap energy and feedstock is the key issue in cost advantages.

The long run solution is to encourage the growth of the Saudi labour force and increase the average productivity level of workers by implementing the following measures: education quality and quantity at all levels, is the main base for skilled labour development. The larger the number of students in a country the larger the potential of skilled labour. Also we should not ignore the quality of the students in a country like Saudi Arabia, which is seeking industrialisation.

The country needs technical education and vocational training, the need for technicians, skilled and semi-skilled, is very critical because most of the technical manpower working in the Kingdom at the present time are foreigners who need to be replaced by

Saudis. So the government established the General Organisation for technical education to be in charge of technical education which is under the Ministry of Education. By 1980 there was six vocational schools existing in the country and a technical, industrial institute and Royal Technical Institute.

The country also needs training and distribution of labour, the kind of training depends on the labour skill and on the nature of the job. The majority of unskilled labours are illiterate which makes training more difficult, because training requires a level of literacy in order to help the trainee to read instructions and follow them. An efficient distribution of labour must direct the right person to the right job this would help to increase the output, decrease losses from the misuse of capital equipment and create more suitable grounds for technology transformation. The improvement of managerial personal specially those at the top are needed by appointed qualified and experienced persons and by regular training. Then we can obtain a better and efficient distribution of labour.

The improvement of production techniques is necessary because one of the main reasons of labour distribution is to increase the productivity of labour. Also, since labour training should always be

updated, capital equipment must also be modernised. By changing the technique of production to the better, one can expect a better base for skilled labour creation and then the level of production will be better from both workers and the industry. The supply of foreign labour should be limited in terms of quantity and quality and the type of workers. Also efficient work conditions such as housing, transport and other services should be made available in order to increase the productivity of labours.

The possibilities of other alternatives to the petrochemical industry were examined for example consider industries based on agriculture which are not feasible in the desert. The poor soil quality, scarcity of water and shortage of labour hindered the agriculture activities. Ground water and surface water fell short of the requirements, and the reliance on the desalinated seawater to irrigate the agricultural crops would be unprofitable and very costly.

Another possibility is to export LNG, but the cost of transportation of petrochemical is very low compared to LNG. Therefore, manufacturing petrochemicals and exporting the unneeded liquified gas are the best way to decrease the cost of transportation especially for Saudi Arabia which is

far away from Europe and US than other gas producing regions around the consuming countries.

Investing the oil money abroad and live on the proceeds is another alternative: the local investment preferred more than the foreign investment as a means of alleviating the country's immediate problems. Infrastructure projects were to be constructed to enlarge the absorptive capacity of the economy and thus help to ease the high inflation rate. Also the return to Saudi Arabia in the form of interest in the foreign investment market ignore the world inflation levels which decrease the earning level of interests to a very low level and could result in a negative interest rate in the long run.

Another alternative could be investing on the aluminium industry which is also energy and capital intensive industry: the aluminium industry was planned in Jubail only for domestic market rather than to be exported to the international markets, because aluminium depends heavily on raw materials such as "bauxite" which is not available abundantly in Saudi Arabia. The raw materials transportation cost would be doubled which would eliminate the competitive pricing in the international market. Also the possibilities for recycling aluminium on a large scale which would save 95 percent of the energy input to

primary smelting are being explored. All these changes in the aluminium industry prove that the petrochemical industry is the best alternative for Saudi Arabia.

In conclusion a successful petrochemical industry can play a dynamic role in accelerating economic development in Saudi Arabia. With its high linkage effects, it should be able to assist directly the integration of the crude oil sector with the rest of the economy. It has been regarded as a strategic factor for the inducement of future industrial development in the country. The petrochemical industry were considered economically feasible for Saudi Arabia, because of the cost advantages in energy and raw materials. So any export-orientated projects in Saudi Arabia must be related to oil and gas production.

BIBLIOGRAPHY

- ADELMAN, I. (1971) Theory of Economic Growth and Development.
Stanford: Stanford University Press.
- AKHADAR, F. (1974) Multinational Firms and Developing Countries:
A Case Study of the Impact of the Arabian American Oil
Company "ARAMCO" on the Development of the Development of
the Saudi Arabian Economy, Ph.D dissertation at UC
Riverside.
- AKHDAR, F. M. (1980) The Philosophy of Saudi Arabia's
Industrialisation Policy, Boulder: University of Colorado
ICEED.
- AL-ANBARI, A. A. (1981) "The Fundamental Energy Issues in the
Developing World" OPEC Seminar on Energy and Development:
Options for Global Strategies. Vienna, Austria.
- AL-JANABI, A. (1979) "Production and Depletion Policies in
OPEC". OPEC REVIEW 3, No. 1.
- AL-SABAH, A. K. (1978) Comments on the OPEC Seminar on Downstream
Operations Proceedings of the OPEC Seminar on Downstream
Operations in OPEC Member Countries: Prospects and
Problems. Vienna, Austria: 9-11 October.
- ALI, T. A. (1984) Regional Industrial Cooperation: Further
Considerations, Kuwait: Industrial Bank of Kuwait,
November.
- ARAMCO Handbook (1964) Dahrán, Saudi Arabia: Arabian American Oil
Company.
- BALASSA, B. (1961) "Towards a Theory of Economic Integration".
Kyklos, 14, No. 3.
- BARNETT, H. J. and MORSE, C. (1963) Scarcity and Growth: The
Economics of Natural Resources Availability. Baltimore:
The Johns Hopkins University Press.
- BOADWAY, R. W. and BRUCE, N. (1984) Welfare Economics, Oxford:
Basil Blackwell.
- BOADWAY, R. W. (1979) Public Sector Economics, Cambridge,
Massachusetts: Winthrop Publishers, Inc.
- BRITISH PETROLEUM COMPANY (1984) British Petroleum Statistical
Review of World Energy.
- BRITISH PETROLEUM (1977) Our Industry: Petroleum, 5th Edition,
London: British Petroleum.
- BROWN, C. V. and JACKSON, P. M. (1986) Public Sector Economics,
Basil Blackwell, Oxford, 3rd Edition.

- BURHAM, M. (1980) "Arabian Petrochemical Industry", A Paper Presented to the Organisation of the Arab Petroleum Exporting Countries. Seminar on Hydrocarbon Industries, Kuwait: (In Arabic).
- BURHAM, M. (1983) "The Best Utilisation of Natural Gas in the Arab Countries" in The Arab Oil Industry, Kuwait: Organisation of the Arab Petroleum Exporting Countries (in Arabic).
- BUSSEY, Lynn E. (1978) The Economic Analysis of Industrial Projects. Englewood Cliffs, NJ: Prentice-Hall, Inc.
- Chemical Week (1980), November 5th.
- Chemical and Engineering News (1985), November 25.
- Chemical Engineering News (1984), 2 April and December.
- Chemical Economic and Engineering Review (1982), October.
- CHEMICAL SYSTEM INC. (1978) The Future of Ammonia Business.
- Chemistry and Industry (1976), No. 22, 20th November.
- Chemistry and Industry (1974), No. 11, 1st June.
- CHEMTECH (1986) Petrochemicals from Saudi Arabia, February.
- COLM, G. and GEIGER, T. (1962) Development of Emerging Countries, Washington, D. C.: Brookings Institution.
- COOLEY, J. K. (1976) "Saudi Arabia Planning It's Future". Christian Science Monitor, 22 March.
- CORBET, J. (1982) "Hazardous Waste Managers are Cleaning Up" Chemical Business, June 28.
- CRANE, R. D., (1978), Planning the Future of Saudi Arabia: A Model For Achieving National Priorities New York: Praeger Publishers.
- DASGUTA, P. (1972) "A Comparative Analysis of the UNIDO Guidelines and the OECD Manual". Bulletin, Oxford University Institute of Economics and Statistics, Vol. 34, February.
- DIAMOND, M. (1982) "Electricity and Water Production: Dual Purpose Plant in Qatar", Proceeding of the Second Arab Energy Conference, Doha, Qatar: March.
- DORF, R. C. (1978) Energy and Resources Policy, Reading, Massachusetts: Addison Wesley.
- EATWELL, J., MILGATE, M. and NEWMAN, P. (ed) (1987) The New Palgrave a Dictionary of Economics.

- EDEN, R. and Others (1982), Energy Economics: Growth, Resources and Policies, London: Cambridge University Press.
- EL-AZHARY, M. S. (ed) (1984) The Impact of Oil Revenues on Arab Gulf Development, London: Croom Helm.
- EL-GHANDOUR, A. (1975) "Economic Cooperation and Integration Efforts in Selected Countries of Western Asia". In ECWA, Studies on Development Problems in Countries of Western Asia. New York: United Nations.
- EL-MALLAKH, R (1982) Saudi Arabia: Rush to Development, London: Croom Helm.
- EL-MALLAKH, R. (1968) Economic Development and Regional Cooperation: Kuwait, Chicago: University of Chicago Press.
- EL-MALLAKH, R. (1981) An Overview of the Third Development Plan of Saudi Arabia. Boulder, The International Research of Energy and Development.
- EL-MALLAKH, R. and EL-MALLAKH, D. (ed) (1982) Saudi Arabia Energy, Developmental Planning and Industrialisation, Lexington, Massachusetts: D. C. Heath and Company.
- EL-ZAIM, I. (1982) "Energy and Industry with special Reference to the Arab Countries", Proceeding of the Second Arab Energy Conference Doha, Qatar: March.
- FACTS AND FIGURES (1970-1982): Achievements of the Development Plans, Saudi Arabia: Ministry of Planning.
- FISHER, A. C. and KRUTILLA, J. V. (1975) "Resource Conservation, Environmental Preservation and the Rate of Discount", Quarterly Journal of Economics, Vol. 89.
- GITTINGER, J. P. (1972), Economic Analysis of Agricultural Projects, Baltimore: The Johns Hopkins University Press.
- GLASSNER, M. (ed) Global Resource: Challenges of Interdependence New York: Praeger.
- GOLDSTEIN, R. F. and WADDAMS, A. L. (1967) The Petroleum Chemicals Industry, 3rd Edition, London: E and F. N. Spon Ltd.
- GORST, I. (1984) "Entering the Downstream Market", The Petroleum Economist, November.
- GRAMLICH, E. J. (1981) Benefit-Cost Analysis of Government Programs, Englewood Cliffs, New Jersey: Prentice-Hall, Inc.
- HABLUTZEL, R. (1981), "Issues in Economic Diversification for the Oil-Rich Countries", Finance and Development, June.
- HAMBLETON, H. G. (1980) The Saudi Petrochemical Industry in the 1980s, Report Submitted to the Royal Commission.

- HAMPLE, C. A. (1976) Glossary of Chemical Terms, New York: Van Nostland, Reinhold, Ltd.
- HANSEN, K. (1978) "Investment and Location Policies of Transnational in Petrochemicals", Proceedings of the OPEC Seminar on Downstream Operations in OPEC Member Countries: Prospects and Problems, Vienna, Austria: 9-11 October.
- HARVEY, C. (1983) Analysis of Project Finance in Developing Countries. London: Heinemann.
- HERRICK, B. and KINDLEBERGER, C. P. (1983) Economic Development, 4th ed., New York: McGraw-Hill Book Company.
- "How to Upgrade Heavy Feeds" (1984) Hydrocarbon Processing, February.
- HUNKER, H. L. (1974) Industrial Development, Lexington, Massachusetts: D. C. Heath and Company.
- Hydrocarbon Processing (1981), January and June.
- INDUSTRIAL STUDIES AND DEVELOPMENT CENTRE (1977) A Guide to Industrial Investment in Saudi Arabia, Riyadh, Saudi Arabia: Industrial Studies and Development.
- IRVIN, G. (1978) Modern Cost-Benefit Methods, London: The Macmillan Press Ltd.
- ISENMAN, P. (1973) "Comments", Proceedings of the Symposium of the Use of Socioeconomic Investment Criteria in the Project Evaluation, Washington, D. C: Inter-American Development Bank, March.
- JAIDAH, A. M. (1978) "Downstream Operations and Development of OPEC Member Countries". Proceedings of the OPEC Seminar on Downstream Operations in OPEC Member Countries: Prospects and Problems. Vienna, Austria: 9-11 October.
- KENESSEY, Z., (1978), The Process of Economic Planning, New York: Columbia University Press.
- KINDLEBERGER, C. P. (1965) Economic Development, 2nd ed. New York: McGraw-Hill Book Company.
- KING, J. A. (1967) Economic Development Projects and Their Appraisal, Baltimore: The Johns Hopkins University Press.
- KINGDOM OF SAUDI ARABIA, CENTRAL PLANNING ORGANISATION, (1970), Development Plan.
- KUBURSI, A. A. (1984) Oil, Industrialisation and Development in the Arab Gulf States, London: Croom Helm.
- KUZNETS, S. (1959), Six Lectures on Economic Growth, Glencoe, New York: Free Press.
- LAYARD, P. R. G. and WALTERS, A. A. (1978) Microeconomic Theory,

London: McGraw-Hill Inc.

LEWIS, A. W., (1966), Development Planning: The Essentials of Economic Policy New York: Harper and Row.

LEWIS, A. W. (1955) The Theory of Economic Growth. Homewood, III: Richard D. Irwin, Inc.

LIPSEY, R. (1960) "The Theory of Customs Unions: A General Survey". Economic Journal, 70, September.

LIPSEY, R. G. and LANCASTER, K. J. (1956), "The General Theory of Second Best" Review of Economic Studies, 24.

LITTLE, I. M. D. and MIRRLEES, J. A. (1974) Project Appraisal and Planning for Developing Countries, New York: Basic Books.

LORI, J. H. and SAVAGE, L. J. (1955) "Three Problems in Rationing Capital", Journal of Business, October.

Manual of Industrial Project Analysis in Developing Countries, Vol. II (1969) Social Cost-Benefit Analysis (Paris: OECD).

MAULL, H. W. (1981) Natural Gas and Economic Security. English Version Paris: Atlantic Institute for International Affairs.

MEADE, J. (1955) The Theory of Customs Unions. Amsterdam: North Holland Publishing Company.

MEIER, G. M. and BALDWIN, R. E. (1957) Economic Development: Theory, History, Policy. New York: John Wiley and Sons, Inc.

Middle East Economic Survey (1982), 25, No. 17 (February 8).

MILMO, S. (1982) "How Do European Chemical Producers Spell 'Anxiety'?" A-R-A-B-S, Chemical Business, March 8th.

MINISTRY OF FINANCE AND NATIONAL ECONOMY (1984) Indicators of Downstream Industries

MINISTRY OF PLANNING (1985) Fourth Development Plan (1985-1990), Riyadh, Saudi Arabia.

MINISTRY OF PLANNING (1980) Third Development Plan (1980-1985) Riyadh, Saudi Arabia.

MINISTRY OF PLANNING (1970) Second Development Plan (1975-1980) Riyadh, Saudi Arabia.

MISHAN, E. J. (1988) Cost-Benefit Analysis 4th ed. London: Allen and Unwin.

MONTAGU, C. (1987) Industrial Development in Saudi Arabia, Report Published in London by The Committee for Middle East Trade.

- MOORE, F. T. (1984) Technological Change and Industrial Development: Issues and Opportunities. Washington, D. C. World Bank.
- MORGAN, T. and BETZ, G. W. (ed) (1970) Economic Development: Reading in Theory and Practice, Belmont, California: Wadsworth Publishing Co. Inc.
- MUSTAFA, A. (1981) "The Utilization of the Natural Gas in the Arab Countries". A Paper presented to the Organisation of Arab Petroleum Exporting Countries Seminar on the Oil Industry, Kuwait.
- MYRDAHL, G. (1956), An International Economy, New York: Harper and Row.
- NAZER, H. (1985) Chemical Marketing and Reporter, October 28.
- NEWMAN, D. G. (1983) Engineering Economic Analysis, San Jose, Calif: Engineering Press, Inc.
- NIGERIAN NATIONAL OIL CORPORATION (1982), Progress of Public Sector Participation in Nigerian Oil Industry, Lagos.
- NYROP, R. F. (ed) (1977) Area Handbook for Saudi Arabia, Third Edition, Washington, D. C. American University.
- OKUN, B. and RICHARDSON, R. W., (1961) Studies in Economic Development. New York: Holt, Reinhart and Winston, Inc.
- OPEC Secretariat, Energy Studies Department (1984) Report on the Impact of Member Countries Product Export on Crude Oil Prices. Vienna: December.
- OPEC Annual Statistical Bulletin (1983).
- OPEC (1978), Seminar on Downstream Operations in OPEC Member Countries-Prospects and Problems. Proceedings October 9-11. Vienna, Austria.
- OPEC Annual Report (1983).
- "OPEC Refineries Will it Pay to Export Products?" (1983), Petroleum Economist, May.
- Organisation for Economic Co-operation and Development (1979) The Petrochemical Industry: Trends in Production and Investment to 1985. Paris, OECD.
- ORGANISATION OF THE PETROLEUM EXPORTING COUNTRIES ENERGY STUDIES DEPARTMENT (1978). Proceeding of the OPEC Seminar on Downstream Operations in OPEC Member Countries, Prospects and Problems. Vienna, Austria: 9-11 October.
- PEARCE, D. W. and ROSE, J. (ed) (1975) The Economics of Natural Resource Depletion, New York: John Wiley and Sons Inc.

- PEEBLES, M. (1980), Evolution of the Gas Industry, New York: New York University Press.
- PETERSON, F. M. and FISHER, A. C. (1977) " The Exploitation of Extractive Resource: A Survey", The Economic Journal, Vol. 87, December.
- Petroleum Economist (1972), November.
- PETROLEUM ECONOMIST (1986) "Prospect for the Natural Gas Trade", Editorial, May.
- PETROLEUM CHEMICALS (1975) BP Handbook for Teachers, BP Educational Services.
- PIGOU, A. C. (1932) The Economics of Welfare, London, Macmillan.
- PRESLEY, J. R. (1984) A Guide to the Saudi Arabian Economy, London: The Macmillan Press Ltd.
- QAYUM, A. (1975) Techniques of National Economic Planning, Bloomington, Ind.: Indiana University Press.
- QUINLAN, M. (1983) "Chemicals: Profits Continue to Decline" Petroleum Economist, July.
- RAY, A. (1986) Cost-Benefit Analysis Issues and Methodologies Baltimore: The Johns Hopkins University Press.
- REUBEN, B. and BURSTALL, M. (1973) The Chemical Economy, London: Longman Group, Ltd.
- ROBSON, P. (1980) The Economics of International Integration. London: Longman Group Ltd.
- ROEMER, M. and STERN, J. J. (1981) Cases in Economic Development: Projects, Policies and Strategies, London: Butterworths.
- ROEMER, M. (1981) "Dependence and Industrialisation Strategies" World Development, 9, No. 5.
- ROYAL COMMISSION OF JUBAIL AND YANBU (1979) Annual Report 1979, Riyadh: Royal Commission.
- SABBAB, A. (1977) Planning and Development in Saudi Arabia, OCAZ Publishing Company.
- SAUDI ARABIAN BASIC INDUSTRY CORPORATION REPORT (1978) Saudi Arabia: SABIC.
- SCHIAVO-CAMPO, S. and SINGER, H. W. (1970) Prospects of Economic Development Boston: Houghton Mifflin Company.
- SCOTT, A. (1955) Natural Resource: The Economics of Conservation, Toronto: University of Toronto Press.
- SCT Methanol Project Feasibility Study (1979) Volume 5, June.

- Second World-Wide Study on the Petrochemical Industry Process of Restructuring, 1981, Annex II.F.
- SELTON, F. (1971) "Shadow Wage Rates for the Chilean Economy", OECD, Paris.
- SENKON, S. and STAUFFER, N. (1981) "What to Do with Hazardous Waste", Technology Review, November/December.
- SHANER, W. W., (1979) Project Planning for Developing Economics. New York Praeger.
- SIMON, J. L. and KHAN, H. (ed) (1983) The Resourceful Earth: A Response to Global 2000, New York: Basil Blackwell, Inc.
- SMITH, V. K. (ed) (1979) Scarcity and Growth Reconsidered, Baltimore: The Johns Hopkins University Press.
- SOLOMON, E. (1956), "The Arithmetic Capital-Budgeting Decision", Journal of Business, April.
- SPITZ, P. H. (1978) "Outlook for OPEC Member Countries in Downstream Operations". Proceeding of the OPEC Seminar on Downstream Operations in OPEC Member Countries: Prospects and Problems. Vienna, Austria: 9-11 October.
- STENGER, H. H. (1980) "The Problems and Pressures on the European Chemical Industry", Chemistry and Industry, 6 December.
- SUTCLIFFE, R. B. (1971) Industry and Underdevelopment, London, Addison-Wesley Publishing Company.
- TINBERGEN, J. (1954), International Economic Integration, Amsterdam: Elsevier.
- TINBERGEN, J. (1967) Development Planning, New York: McGraw-Hill Book Company.
- TODARO, M. P. (1971) Development Planning: Models and Methods, London: Oxford University Press.
- TODARO, M. P. (1981) Economic Development in the Third World, 2nd ed. New York: Longman.
- TORRENS, I. M. (1980) Changing Structures in the World Oil Market. Paris: Atlantic Institute for International Affairs.
- TORRI, Y. (1978) "Problems of Technology and Marketing: An Appropriate Approach for OPEC", In Proceedings of the OPEC Seminar on Downstream Operations: Prospects and Problems. Vienna, Austria.
- TRESCH, R. W. (1981) Public Finance: A Normative Theory, Plano, Texas: Business Publications, Inc.
- TRIPATHY, R. N. (1964) Public Finance in Under-Developed Countries, Calcutta, India: The World Press Private Ltd.

- TURNER, L. and BEDORE, J. (1979) Middle East Industrialisation: A Study of Saudi and Iranian Downstream Investments. New York: Praeger.
- United Nations (1964), Conference on Trade and Development (UNITAD), Proceedings, Vol. I, "Final Act and Report", New York: UN.
- United Nations (1979) "Industrial Development Organistion", Industry and Development, No. 1, Vienna: UN
- UNITED NATIONS DEVELOPMENT ORGANISATION (1972) Guidelines for Project Evaluation, New York: United Nations.
- UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANISATION (1973) The Petrochemical Industries, Vienna: US Publication.
- UNITED NATIONS (1966) The First UN Conference on the Development of Petrochemical Industries in Developing Countries, New York.
- US Department of Energy, Office of Oil and Gas (1977) Trends in Desulphurisation Capabilities, Processing Technologies, and Availability of Crude Oil., Washington, D. C.
- VALLENILLA, L. (1975) Oil: The Making of a New Economic Order, Venezuelan Oil and OPEC, New York: McGraw-Hill Book Company.
- VERNON, R. (1966) "Comprehensive Model-Building in the Planning Process: The Case of Less Developed Countries", The Economic Journal, London: Macmillan Limited, March.
- VINER, J. (1950) The Customs Union Issue, London: Carnegie Endowment for International Peace.
- WATERSTON, A. (1965) Development Planning: Lessons and Experience, Baltimore: The Johns Hopkins University Press.
- WATERSTON, A. (1973) "Comments" Proceedings of the Symposium on the Use of Socioeconomic Investment Criteria in the Project Evaluation, Washington, D. C.: Inter-American Development Bank, March.
- WILLIAMS, R. (1982), "Reindustrialisation: Past and Present", Technology Review, 85, No. 8 (November-December).
- YOTOPOULOS, P. A. and NUGENT, J. B. (1976) Economics of Development, New York: Harper and Row.