THE DEPLETION THEORY OF EXHAUSTIBLE RESOURCES.

A CASE STUDY OF SAUDI ARABIA

BY

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To my family

in appreciation and love

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Abstract

The overall aim of this study is to examine the optimal depletion policy for Saudi crude oil in the light of its impact on the economic process and the absorptive capacity of the country in order to judge to what extent the rate of oil depletion is optimal.This, of course,raises a question about the future of the Saudi economy after the oil has been depleted and entails some policy implications. In order to achieve the main objective,it is useful to examine the depletion theory in general and the depletion of oil in particular with its application to the Saudi economy through the estimation of the government's goal function. A non-linear regression model and a discount form of a dynamic recursive linear model will be used to estimate the future demand for Saudi crude oil. A price leadership model will be presented when discussion is to be made about the structure of the oil market. The impact of oil revenue on the Saudi economy will also be discussed to point out the importance of oil revenue on economic planning and foreign exchange earnings. Finally a macroeconomic model will be presented to measure the impact of oil depletion and its subsequent revenue on the Saudi absorptive capacity. A summary and some concluding remarks will then follow.

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INTRODUCTION

One of the most striking features of the distribution of natural resources is that they are arbitrarily scattered when compared with the distribution of the world's population.

There are, of course, many different kinds of natural resources some of which play a crucial role in economic development. Oil is one such resource and is the main raw material for the world's energy needs.

W.A. Lewis (1949), emphasised the role of natural resources in economic development. He pointed out that most of the important natural resources have been scattered in a small area when compared to the world's population.[1] To take as an example, Saudi Arabia, Kuwait and other gulf states possess huge reserves of oil compared with their small populations. On the other hand, India and some other LDCS, lack many essential resources and as a result their populations suffer from poverty and economic stagnation.

It is argued that until the beginning of this century, very little was known about the stock of natural resources in LDCS. This was due to the fact that advanced exploration techniques did not exist

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[1] W. A. Lewis, Economics, Man and His Material Resources, Odhams Press Ltd. Long Acre London;1949 Chapter 1.

these countries.

Due to the importance of natural resources in economic development, many economists have taken an interest in the subject.[2]

The progress of LDCS, however, cannot take place without the economic, political, cultural and Social factors which all together shape the path and the speed of economic development. With this arbitrary distribution, some LDCS are now experiencing rapid economic growth. The oil exporting countries, for instance, although still seen as developing countries, are carrying out a massive development programme aimed at diversifying their economic base(s). Natural resources, therefore, are both a source of revenue, attract foreign capital and act as an engine for growth.

Different natural sources require different exploitation techniques. Oil, for example, is highly capital intensive, from the initial exploration stage right through to its production and marketing. As a consequence, many LDCS are unable to successfully develop their own resources as they may lack both the capital and know-how. Exploitation of oil in LDCS, therefore, has been carried out by the multi-national oil companies which were until recently either European or American. Consequently, most remaining LDC exports were (and still are in many cases) primary products which are either raw materials or semi-processed

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2 N.S.Buckanan and H.S.Ellis, Approach to economic development,the twentieth century fund,Inc,USA,1955 , Chapter 1.

products of these materials.

W.A. Lewis (1949), suggested that international trade between developed and less developed countries would alleviate the poverty problem. Those who support his view argue that free trade would benefit LDCS through the exchange of raw materials for new technology and foreign capital.They claim that specialization according to a comparative advantage principle would lead to a greater efficiency and increase welfare. On the other hand, it is argued that industrial countries will benefit disproportionately from free trade. This is because, raw material prices fluctuate, the need for such material in the developed world is declining and because industrial products are becoming more sophisticated. This situation slows down the rate of industrialization in LDCS, fewer jobs are created and the strain on balance of payments is increased. Furthermore, any deterioration in terms of trade for the producer of raw materials will affect their real gain from exports.

This study is concerned with the role of natural resources in the development of the Saudi Arabian economy.In particular, it focuses upon the significance of oil as the mechanism of economic growth. Although, other raw materials do exist, they are not of any real significance. They are either too difficult to exploit, or have been recently discovered, and as such do not as yet contribute to the GDP of the country.

Oil is the main source for the Saudi domestic and international revenue and as such plays an essential

role in changing an undeveloped society into a developed modern industrial state. The overall aim of this study is therefore to examine the optimal depletion policy for the Saudi oil in the light of its impact on the economic development process in Saudi Arabia and its absorptive capacity to judge to what extent the rate of oil depletion is optimal. This, however, will give rise to a question about the future of the Saudi economy and allow for some policy prescriptions.

In order to achieve the main objective of the study, it is useful to estimate the direct impact of oil revenue on the Saudi economy. This will involve discovering the implications of oil revenue on two indicators of economic developments; economic planning and foreign exchange earnings.

In chapter 3 we will be analysing the role of foreign investment in developing oil resources in Saudi Arabia. This also covers the forms of foreign investment and the relationships between the government and multi-national oil companies.

Chapter 4 deals with the theory of natural resources depletion; depletion of oil resources and an examination as to whether the world's natural resources are being depleted too rapidly or too slowly.

The next step is to examine the depletion policy in Saudi Arabia but we would rather examine the structure of the oil market through which a price leadership model will be presented. Chapter 5 also deals with the estimation of the future demand for Saudi crude oil by using a non-linear regression model and a discount form

of a dynamic recursive linear model. This is followed by the estimation of the present value of net oil revenue during the planning period.

In chapter 6 we will examine the major changes that have occurred in the energy market from 1950 until recently and we will also, explain the factors that have contributed to these changes.

The final chapter will examine the impact of oil depletion on the absorptive capacity of Saudi Arabia through which a macroeconomic model will be constructed to measure the sectoral absorptive capacity in the kingdom which will be followed by some concluding remarks and some policy implications.

CHAPTER TWO

THE IMPORTANCE OF OIL REVENUE IN THE SAUDI ARABIAN ECONOMY

Before the discovery of oil, Saudi Arabia was one of the poorest countries in the world. The majority of the population were involved in fishing and some maritime trading amongst the Gulf states. The remainder were bedouins moving from one place to another, their locations being determined by the availability of water and pastureland for their animals and themselves.

Since 1939, when the first oil was produced, the Saudi Arabian economy has changed dramatically. At the outset development was almost non-existent since control of the resources was in foreign hands. Since the early Seventies, however, the kingdom has experienced rapid economic growth due to the quadrupling of oil prices and to an ambitious development programme. Today, the kingdom possesses an oil-based economy in which oil is the main source of foreign exchange earnings. Consequently, the oil sector is the dominant sector in the economy.

Saudi Arabia possesses the world's largest reserves of oil. It has been estimated at about 168,32 billion barrels of proven recoverable reserves, which equates to about one quarter of the total world

reserves.[1] The kingdom has not only the highest amount of reserves, it is also first in production. The rate of oil production ranged from a very low level before 1973 to a peak in 1980. The reason behind this may be explained by a low level of International demand for oil in the earlier period and the influence of multi-national oil companies in oil production. Table (2.1) indicates that the rate of oil production was very low during the early Sixties and started rising steadily from 1965 and onwards as the result of a rising demand for oil until it reached its peak in 1980. Table (2.1) also shows that the rate of oil production in Saudi Arabia witnessed a downward trend from 1982 and onwards. The reason could be well attributed to the reduction in international demand for oil as a result of high oil prices. The fall in demand for oil has been brought about by the following factors: the increased use of other energy sources; conservation measures which have been taken by industrial countries to reduce the consumption of oil and crude - oil imports and an increase in supply of oil from non-OPEC countries. Consequently, the rate of oil production in Saudi Arabia fell from 9.80 million barrels a day in 1980 to 3.45 m b/d in 1985. The rate of growth of oil production fell by 19.0 per cent compound on average during that period. Consequently oil revenues, however, fell from 204,903 million Riyals in 1982/83 to 118,15 million Riyals in 1984/85 as a result of the falling amount of oil

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[1] Ministry of Petroleum and Mineral Resources in Saudi Arabia, Petroleum statistical Bulletin, 1982.

exports.[2]

Table (2.1)

Saudi Arabian Annual Production of crude oil

(millions of U.S. barrel)

YEAR	TOTAL	MILLION BARREL A DAY
1960	481.30	1.33
1961	540.70	1.50
1962	599.70	1.66
1963	651.80	1.81
1964	694.30	1.93
1965	804.90	2.24
1966	950.00	2.60
1967	1024.00	2.80
1968	1113.70	3.09
1969	1174.00	3.26
1970	1316.70	3.85
1971	1740.60	4.79
1972	2202.00	6.02
1973	2772.60	7.60
1974	3095.10	8.48
1975	2582.50	7.08
1976	3139.30	8.61
1977	3358.00	9.21
1978	3030.00	8.30
1979	3479.40	9.53

[2] Saudi Arabia Monetary Agency,Annual Report,1986,p.65.

1980	3623.50	9.90
1981	3538.80	9.83
1982	2347.20	6.52
1983	1818.00	5.05
1984	1684.80	4.68
1985	1242.00	3.45

Sources: Saudi Arabian Monetry Agency, Annual Report (1969),p.83; Ministry of Petroleum and Mineral Resources, Petroleum Statistical Bulletin's 1976,p.11 ; 1980,p.17;Also oil and gas journal March 8,14,12,10, 1982,1983,1984 and 1986.

Given the overwhelming importance of the petroleum sector in the Saudi economy, it is necessary to outline the effects of oil revenue on two indicators of economic development, economic planning, foreign exchange earnings and balance of payments. Each of these will be discussed in turn.

2.1 The Effect of Oil Revenue on Economic Planning in Saudi Arabia

Comprehensive planning is a method used by developing countries to allocate resources in a productive way to promote growth and particular structural changes. Planning is a multi-stage process and success in achieving its targets depends heavily upon the proper execution of each stage with no exception. These plans of course will depend on a

country's political and economic institutions and aspirations.

Planning in Saudi Arabia and developing countries in general is not as successful as that in developed countries.3

Constraints on economic development in LDCS are similar everywhere. The market size in Saudi Arabia is So small that the absorption of manufactured goods economically and efficiently is difficult without regional co-operation to overcome the market problems. In addition, there is a need to stimulate effective demand and private sector whilst preventing inflation. As far as foreign demand is concerned, Saudi Arabia is a net importer of manufactured goods and is dependent on the West and Japan for its supplies. It is assumed that the Saudi Government will be able to export goods, even though, high tarriffs imposed by industrial countries will make this very difficult to accomplish.

The lack of skilled manpower is one of the main constraints on economic development. Skilled human resources are of extreme importance in the execution of any development plans. Saudi Arabia and developing countries alike suffer from a shortage in this crucial factor. In the short term, this problem might be solved by depending on the industrial countries for technical assistance and skilled labour. The government, however, should consider this problem carefully and set a plan for the development of human resources in the long term.

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3 G. Meier, Leading Issue in Economics Development Third Edition, Oxford University Press, 1976, Chapter 13.

The kingdom is, however, aware of this problem and it is trying hard to eradicate illiteracy and sends people abroad for training to take the place of the foreign labour. A major obstacle is that the participation of women in the economy is very low. The tribal traditions and religious taboos have prevented women from participating effectively in the economy.

A further hindrance to economic development in Saudi Arabia is an inadequate administrative capacity and the inability of the economy to absorb expenditure. For example, ports were unable to handle the huge imports of commodities pouring into the country after the oil price increases of 1973. Unlike other developing countries, Saudi Arabia is very rich, so the capital constraint is not existent. Despite the above- mentioned factors and additional factors such as a lack of reliable statistical data, planning for economic development is in evidence. Oil is an exhaustible resource which will be depleted within fifty years. Without this, the government will have no financial resources to carry out its plans. Having realized this, the government has been trying to build up a self-sufficient economy as a means of reaping the benefits of oil revenue. The Kingdom, therefore, has experienced three economic development plans which will be briefly discussed in turn.

2.1.1 The First Development Plan (1970-1975)

The first economic plan was very comprehensive in

so far as projects to promote growth in all sectors of the economy were set up through which the standard of living for the Saudi people was to be raised. This implies that planners were trying to increase the share of certain sectors of the national product and make the oil sector less dominant.

The total outlay for this first plan was 41.3 billion Saudi Riyals which was divided into a current expenditure of SR 22.9 billion and a project outlay of SR 18.4 billion. The aim of this plan, however, is to promote growth in the gross domestic product (GDP) at an annual growth rate of 9.8 per cent.

Table (2.2) indicates that 23.1 percent of the total planned outlay went to defence expressing the determination of the government to increase the Kingdom's military ability as a measure to stabilize the country. It is also believed that the first plan aimed to develop human resources in order to reduce the country's dependency on expatriates, thus to increase the contribution of the Saudi labour force to economic growth. The allocation of social services, therefore, was SR 9,298.8 million or 22.5 per cent of total plan outlay.

More emphasis was placed upon the development of transport and communications in this first plan. 18.1 percent of the total plan outlay was allocated to the transport and communications sector.

Spending on industrial projects was relatively low because of certain recognised constraints such as a skilled labour force. Hence, planners relied heavily on

the private sector to promote industry. Only 2.7 per cent of the total plan outlay was allocated to the industrial sector including mining. The agriculture share of the total plan outlay was only 3.6 per cent.

TABLE (2.2)

FIRST PLAN OUTLAY 1970/71 1974/75 (SR Millions).

SECTORS	CURR. EXPEND.	% OF TOTAL	PROJ. EXPEND.	% OF TOTAL	TOTAL	% OF TOTAL
PUBLIC Administration	6794.6	29.6	922.8	5.0	7717.4	18.6
Defence	3980.0	17.4	5575.0	30.3	9555.0	23.1
Social Services (education,health, labour and social affairs)	77631.1	33.9	1535.7	3.4	9298.8	22.5
urban development and public utilities	1246.9	5.4	3325.4	18.1	4572.3	11.1
Transport and Communications	1767.3	7.7	5709.2	31.1	7476.5	18.1
Industry	321.8	1.4	776.7	4.2	1098.5	2.7
Agriculture	973.8	4.2	493.9	2.7	1467.7	3.6
Trade and Services	83.5	0.4	43.8	0.2	129.3	0.3
Total	22931.0	100.	18382.5	100.	41313.5	100.

Source: R. EL-Malakh, Saudi Arabia Rush to development, Croom Helm,London and Camberra,1982,p.146.

Implementation of any comprehensive plan in developing countries, however, would require a change in the government institutions and consistent efforts to achieve the objectives of the plan. Co-ordination of the ministries in developing countries is a very difficult

task to achieve. In addition, it is very difficult to identify the needs of the country in terms of size and composition of the available resources.

It is also believed that planners in developing countries are seeking to get the country out of a bottle neck by setting up ambitious plans without taking into consideration the mechanism to achieve the objective.

During the preparation of the first plan, Saudi Arabia faced financial difficulties due to the Arab - Israeli war in 1967.

The country's overall balance of payments deficit was SR 360 and SR 527 million in 1968 and 1969 respectively.[4]

The projected revenue of the first plan ranges from SR 33.8 billion to SR 37.4 billion against a total planned outlay of 41.3 billion. Unexpectedly, oil prices increased which raised both government revenue and expenditure, and led to the fulfilment of planned expenditure. Table 2.3 shows the actual government revenue during the first plan which was SR 180.6 billion and actual expenditure of about SR 86.5 billion. The real gross domestic product grew at a rate of 13.0 per cent per annum compound on average which was above the projected. The reason behind this could well be attributed to the growth in the oil sector which was 14.9 per cent. Agriculture and Industry were expected to grow at a rate of 4.6 and 14.0 per cent per annum while actual compound growth rates turned out to be 3 and 11

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4 Saudi Arabian monetary Agency, Annual Report, 1395,(1975), p.51.

per cent. The construction sector, however, performed better than expected, as the actual growth rate was 15 per cent against the projected rate of 10 per cent. Increasing the standard of living of the population was the reason behind the boost in this sector.

TABLE (2.3)

FIRST PLAN ACTUAL GOVERNMENT REVENUE AND EXPENDITURE VERSUS PROJECTION,(Billion Riyals).

	70/71	71/72	72/73	73/74	74/75	TOTAL	5 YEAR PROJ'N
1.Government Revenue	7.9	11.1	15.4	44.8	101.4	180.6	33.8
2.Govt. Expenditure	6.4	8.8	10.1	19.5	42.2	86.5	41.3
Recurrent	4.1	4.9	5.9	9.2	27.2	51.3	22.9
Projects	2.3	3.4	4.2	10.3	15.0	35.5	18.4
3.GDP(annual growth rate) at current prices	31.6	23.3	48.9	150.4	26.4	56.12	37.4
at constant price	14.2	15.5	20.0	14.9	1.5	13.2	9.8

Source: SAMA, Annual report,1978, table 4 p.46.

The first plan, therefore, was successful in so far as actual expenditure exceeded the proposed expenditure. Apart from that, the actual annual growth of GDP exceeded the projected rate of growth by approximately 3.4 per cent.

It is argued, however, that this rate would not have been obtained had the government spent exactly the projected expenditure. In addition, the actual growth rates of the agriculture and manufacturing sectors were very low. Failing to achieve the projected growth rate

in agriculture might be tolerated in developing countries but in the case of industry it was a disappointing result when we consider the efforts of the Saudi government and the planning authority to promote growth in this sector.

Generally speaking, the first plan gave the country its first ever experience of the planning scheme. Even if plan implementation was not up to the standard required, Planners in Saudi Arabia, have had planning experience through the implementation of the first plan. With the financial capability in mind, the second plan could be set-up under different considerations than the size of the oil revenue.[5]

2.1.2 The Second Development Plan 1975-1980

The second development plan was formulated after the oil price increase in 1973 which raised the Saudi revenue in particular from foreign exchange earnings. The major problem encountered, however, was the inability of the Saudi economy to absorb the surplus created during the second plan. The main objective of this plan, therefore, was to increase the absorptive capacity of the economy which required a substantial amount of investment. The second plan also aimed to promote growth in non-oil GDP as a means of diversifying the economy.

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[5] The growth of gross fixed capital formation during the plans will be discussed in chapter 7 when discussion will be made about oil depletion and absorptive capacity.

Table (2.4) shows that the total plan outlay was SR 498.2 billion of which SR 331.6 billion was for projects and SR 166.6 billion for recurrent expenditure.

TABLE (2.4)

SECOND DEVELOPMENT PLAN OUTLAYS (Billion Rivals)

SECTOR	RECURRENT	PROJECTS	TOTAL
Economic Resource Developmen	4.5	87.6	92.1
Human Resources Development	43.9	36.2	80.1
Social Development	18.1	15.1	33.2
Physical Infrastructure Development	12.5	100.4	112.9
Sub total development	79.0	239.3	318.3
Administration and Defence	32.7	83.7	116.4
External Assistance, Emergency funds, Food subsidies and general reserves.	54.9	8.6	63.5
Total	166.6	331.6	498.2

Source: S.A.M.A, Annual Report, 1975 p. 53.

A further objective of the plan was to achieve a high rate of economic growth for all sectors of the economy and to maximize oil revenue in the long term. In other words, the plan aimed to increase the contribution of other sectors to GDP and reduce the dependency on the oil sector which faced decline as the reserves ran out. The gross domestic product is estimated to have grown at an annual rate of 10.2 per cent. Within this figure, the oil sector was seen to

have grown by 9.7 per cent and manufacturing and petrochemical industries by 14.0 per cent.[6] The concentration of the industrial programme was based on the development of hydro-carbon based industries in which the kingdom would exploit through an established economic advantage ; industries essential to national security and Regional manufacturing activities appropriate to the development of self sufficiency. Table (2.5) indicates the expenditures on economic resource development of which 48.1 per cent was allocated to manufacturing.

TABLE (2.5)

EXPENDITURE ON ECONOMIC RESOURCE DEVELOPMENT (SR millions).

	Recurrent	Project	Total	Percentage
Water	101.8	33963.6	34064.8	37.0
Manufacturing	341.4	43939.2	44280.6	48.1
Agriculture	2205.7	2479.2	4684.9	5.1
Electricity	880.0	5360.0	6240.0	6.7
Others	989.6	1875.1	2864.7	3.1
TOTAL	4518.5	87616.5	92135.0	100.0

Source: Ministry Of Planning in Saudi Arabia ,The Second Development Plan, 1975/1976-1979/1980, chapter 4.

The agricultural sector, however, was expected to grow at a rate of 4.0 per cent per year. Planners relied heavily on the private sector to engage in

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6 Ministry Of Planning in Saudi Arabia,The Third Development Plan, 1970/1971_1974/1975, p.49.

development activities in agriculture. In addition, their aim was to raise productivity; increase production, and bring more land into production where ever water was to be found.

One of the second plan objectives was to develop human resources through education and training. Concerning human resource development, The Saudi labour market was characterized by a shortage of labour. The government, therefore, depended heavily on foreign skilled labour to implement the first and the second plans. During the second plan, the estimation of manpower requirements was 800,000 or an increase of 52.0 per cent. The Saudi labour force was expected to increase by about 300,000 and the anticipated shortage of labour would be provided by expatriates.[7] Being dependent on foreign labour, one can imagine the obstacle to the planned implementation. Planners, through the second plan, therefore, realized the importance of a trained and educated labour force to the development of the economy. They aimed to increase the productivity of the Saudi Labour force and bring about the required managerial knowledge.

The second plan, however, was considered successful when compared with the first plan, due to the fact that the actual rate of growth of non-oil sectors (15.1 per cent), exceeded the projected growth of 13.3 per cent per annum. In addition, table (2.6) shows that both the productive and the services sectors achieved actual

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[7] S.A.M.A, Annual Report, 1975, p.55.

TABLE (2.6)

ANNUAL GROWTH RATE DURING THE SECOND PLAN
(Constant price of 1980, SR Billions)

	1975	1980	Planned	Actual
Productive Sectors	26897.7	57854.6	13.0	16.6
Agriculture	2505.8	3259.4	4.0	5.4
Mining	779.1	1497.5	15.0	17.1
Manufacturing	3303.4	6753.3	14.0	15.4
Utilities	117.5	350.1	15.0	24.4
Construction	20291.9	45994.3	15.0	17.7
Service Sectors	39825.4	77112.5	13.3	14.1
Trade	6439.1	17447.1	15.0	22.1
Transport	7756.1	20227.5	15.0	21.1
Finance	7137.8	13144.2	9.7	13.0
Other services	2741.3	5257.3	14.0	13.9
Government	15751.1	21036.4	12.9	6.0
Total non-oil GDP	66723.1	134967.1	13.3	15.1
Oil sector	176076.3	222374.4	9.7	4.8
Gross Domestic Product	242799.4	357341.5	10.0	8.0

Source: Ministry Of Planning in Saudi Arabia, The Third Development Plan,1980/1981-1984/1985 , p. 49.

growth rates of 16.6 and 14.1 per cent respectively, against the projected growth rates of 13. and 13.3 per cent per annum. The actual rate of growth of total GDP, on the other hand, was only 8.0 per cent which was less than the projected figure of 10.2 per cent. The second plan, however, witnessed a rapid increase in purchasing power and an excess demand for goods and services accompanied by a supply shortage which created inflation. Imported inflation can also be added as a major factor for higher prices. In addition, during the second plan, the country still depended heavily on

foreign skilled labour. Table (2.7) indicates that foreign labour grew at a rate of 16.5 per cent per annum, while the annual growth rate of the Saudi's was very low, only 2.4 per cent. Total civilian labour force, however, grew at a rate of 7.2 per cent per annum. Thus, the labour market in Saudi Arabia in general is still very rigid concerning Saudi participation especially in terms of social services. In addition, the share of the Saudi female labour force during the second plan was still very small.

TABLE (2.7)

ANNUAL GROWTH RATE OF CIVILIAN LABOUR FORCE. (THOUSANDS)

	1975	1980	Annual growth rate
Male	1651	2323	7.1
Female	46	148	9.0
Total of which	1747	2471	7.2
Saudi's	1253	1441	2.4
Foreigners	494	1060	16.5

Source: Ministry of Planning in Saudi Arabia, The Third Development Plan, p. 53.

Despite these constraints, the second plan was successful in a sense that the absorptive capacity of the economy was increased together with the removal of the constraints of infra structure. With this in mind, planners of the third plan will have to consider other targets such as raising productivity and increasing the Saudi labour force to replace the need for expatriates.

2.1.3 The Third Economic Plan 1980-1985

During the early stages of the third plan, Saudi Arabia became one of the most powerful financial countries in the world as it became the major oil exporter to the industrial countries. Its duties and responsibilities were increased not only economically but also politically. The third plan, therefore, started in a better position than the previous plans. Saudi absorptive capacity had been improved, and the inflation level was reduced by increasing the supply of goods.

Unlike the first and the second plans, the third aimed to raise the rate of growth in certain areas, notably heavy industry which was expected to grow at a rate of 18.8 per cent. Planners realized that such industries should be publicly owned and directed due to the nature of activity.

Table (2.8) indicates that a total of SR 783 billion (in current prices) was allocated to the third plan, with 33.4 and 31.8 per cent of total expenditure being allocated to the development of economic resources and physical infrastructure respectively.

The projected rate of growth of non-oil GDP was reduced from an average of 15 per cent a year in the second plan to 6.2 per cent during the third plan. The policy was to prevent rural-urban migration; to reduce the dependency on foreign labour and to increase productivity by reducing the unit cost through an

TABLE (2.8)

TOTAL EXPENDITURE OF THE THIRD PLAN

	Amount	Percentage of Total
Economic Resource Development	261.8	33.4
Human Resource Development	129.6	16.6
Social Developemnt	61.2	7.8
Physical Infra-structure Development	249.1	31.8
Sub Total Development	701.7	89.4
Administration, subsidies and contingency reserve	81.0	10.4
TOTAL	782.7	100.0

Source: Ministry of Planning in Saudi Arabia, The Third Development Plan, p.91.

increase in production. The third plan also aimed to develop human resources through fully exploiting available human resources. The plan, therefore, envisaged an increase of Saudi labour force in order to reduce the dependency on expatriates. Foreign labour, however, was expected to fall due to a decline in the construction sector in that period. The foreign labour force is expected to grow at a rate of only 0.2 per cent. In addition, lower growth indicated that planners hoped to increase the labour participation of the Saudis and to keep down inflation levels. Employment of Saudi labour was expected to rise by 1.9 per cent during the third plan. In other words, the Saudi labour force was expected to increase by 146.000 out of a total increase of 155,000.[8] The plan also endeavoured to utilize

8 Ministry of Planning in Saudi Arabia,The Third Development Plan, p.98.

domestic and foreign skilled labour in capital-intensive projects. The second goal of the plan was to create structural changes in the economy so as to pursue a social welfare system.

The third plan seems to be rational in terms of its projected goals, since most of its targets would have been achieved in given circumstances.

The third plan, however, had been successfully completed by the end of 1984/1985. The actual growth rate of non-oil GDP was higher than that projected during the first three years of the plan, namely 8.5 per cent. Increasing oil prices in 1979 and 1980, together with the rise in demand for oil have increased government revenue and government expenditure in turn. The actual growth rate of non-oil GDP, however, fell drastically during the last two years of the third plan, less than 1.0 per cent as a result of falling demand for oil and oil prices which resulted in government expenditure cuts. The overall average actual growth rate was 5.1 per cent per annum. Table (2.9) shows the sectoral projected and actual growth rate during the third plan.

From table (2.9), Agricultural sector registered a growth rate of 8.7 per cent, manufacturing 4.1 per cent and utilities 2.4 per cent. Amongst the service sectors, finance service registered the highest growth of 13.1 per cent. Thus, the performance of the third plan indicated that the productive sector made a significant contribution to non-oil GDP while the oil sector registered a substantial decline of 1.5 per cent

TABLE (2.9)

ANNUAL GROWTH RATE DURING THE THIRD PLAN

(SR Current Prices) (1980 Prices)

	1980	1985	Planned	Actual
Productive Sectors				
Agriculture	4648.3	10575.3	5.4	8.7
Mining	1360.7	1594.3	9.8	5.7
Manufacturing	6466.5	13533.6	18.8	14.1
Utilities	270.8	1486.9	29.5	24.0
Construction	43107.6	45541.4	-2.5	-1.4
Service Sectors				
Trade	17759.7	27591.5	8.4	8.8
Transport	15748.6	23430.6	12.9	7.1
Property	10962.3	12394.9	-	2.1
Finance	4574.5	16695.6	7.3	13.1
Other Services	5260.4	11057.1	3.0	7.9
Goverment	23383.8	54700.1	7.2	5.8
Total Non-Oil GDP	133543.2	215627.7	6.2	5.1
Oil Sector	250046.4	142488.5	1.4	-14.6
Total GDP	383589.6	358116.2	3.2	-5.8

Source: Achievements of the Development Plans, Ministry of Planning in Saudi Arabia, 1985, pp.156-165.

reflecting the weakness in the oil market. Consequently, government revenue fell sharply during the last three years of the plan as the international oil market witnessed a set- back in demand during that period. Table (2.10) demonstrates the government revenues and expenditures during the third plan.

Table (2.10) indicates that oil revenues fell by 22.0 per cent compound on average. total revenue, consequently, fell by 15.8 per cent compound on average. As a result of the falling oil revenue, government expenditure fell by 1.8 per cent compound on average.

TABLE (2.10)

GOVERNMENT REVENUE AND EXPENDITURES DURING THE THIRD PLAN (SR Billion).

	1980/8	1981/8	1982/8	1983/84	1984/85
OIL REVENUES	319.3	328.6	186.0	128.0	118.0
OTHER REVENUES	28.9	39.4	60.2	62.8	157.0
TOTAL REVENUES	348.2	368.0	246.2	190.8	175.0
EXPENDITURES PROJECTS	123.1	140.7	125.7	112.7	100.0
RECURRENT	113.5	144.0	119.2	110.5	120.0
TOTAL EXPENDITURES	236.6	284.7	244.9	223.2	220.0

Source: Ministry of Planning in Saudi Arabia , The Third Development Plan p. 59.

Concerning the labour force development, the growth rate of foreign labour increased by 11.7 per cent per annum compared with the projected one of 0.2 and the number of foreign workers exceeded 1.1 million. The saudi labour force, however, increased by 3.7 per cent per year, though the percentage of the saudi labour force in the total employment figure was reduced from 49.4 per cent in 1980 to 40.2 per cent in 1985.9

The third plan, however, was considered successful in so far as the plan achieved most of its objectives. the fall of government revenue, however, affected the performance of the third plan as expenditure decreased during the last three years of the plan. It is argued, however, that even if Saudi Arabia had reduced its

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9 Ministry of Planning in Saudi Arabia, The Third Development Plan, p. 66.

production, annual revenue would still have been sufficient to finance its development programmes. The Saudi planning minister argued that "There is no relation between the production, pricing of oil and our development".10

Despite what the planning minister said there still existed a strong relationship between the oil revenue and the Saudi development programmes. Oil revenue represented 91.7 per cent of total revenue in 1980 and 67.4 per cent in 1985. Falling oil prices entails that the Saudi government should increase the size of its oil exports in order to receive the same amount of revenue. Increasing the volume of oil exports will worsen the situation as the potential oil price will go down still further. Planners in Saudi Arabia, therefore, should set up a rational plan in terms of their objectives and take into consideration the fluctuation in the oil market, unless the government is prepared to sacrifice some of its foreign assets to meet any urgent circumstances.

Inflation, on the other hand, was still a major task for planners to tackle. The kingdom depended heavily on imports from the OECD which witnessed world-wide inflation. Despite the efforts being made by the government to keep down the rate of inflation (i.e. by increasing domestic production, reducing the cost of services and through the government's fiscal and monetary policies), an inflationary rate of about 7.10 per cent a year is still present even today, since there

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10 The Financial Times, 5th May 1981.

was relatively little the government could do to reduce imported inflation.

2.1.4 The Fourth Development Plan

On March 22nd, 1985, the kingdom issued its fourth plan in order to pursue the fundamental goals, which was set out during the previous plans.

The fourth plan aimed to reduce the dependence on expatriate labour by increasing the participation of the Saudis in the labour market. This was to be done through education and vocational training. This will imply a reduction in quantity and an increase in Saudi labour efficiency.

Development of the productive sectors together with service sector is an additional fourth plan goal as a means of diversifying the economy.

The plan also stressed the need to promote growth in the private sector which would play a leading role in economic growth. Economic and social integration among the member countries of the Gulf co-operation council was one of the fourth plan goals.

In order to achieve these targets, the total projected plan outlay, including non-civilian expenditure, was SR 1000 billion at current prices Civilian expenditure was estimated to be around 687.5 billion of which SR 500 billion was for development. Table (2.11) shows that the pattern of public spending is more selective in this plan than in the previous ones.

TABLE (2.11)

GOVERNMENT SPENDING ON DEVELOPMENT DURING THE FOURTH PLAN (SR Billions).

Spending Category	THIRD PLAN PLAN	THIRD PLAN ACTUAL	FOURTH PLAN PLAN	FOURTH PLAN ACTUAL
Human Resource Development	129.6	124.3	135.3	+8.8
Economic Resource Develop. —	190.7	120.4	130.7	+8.6
Health & Social Services	61.2	69.6	89.7	+28.4
Transport and Communication	138.6	139.1	76.9	-44.7
Municipalities & Housing	89.3	108.9	67.4	-38.1
TOTAL	609.4	562.3	500.0	-11.1

Source: Ministry of Planning in Saudi Arabia ,The Fourth Development Plan, 1985/86-1989/90, p. 103.

The projected rate of growth of total GDP was estimated to be at around 4 per cent which reflects the planners' intention to achieve a stable growth rate rather than the high growth rates which were attained during the previous plans. The estimated growth of non-oil GDP is 2.9 per cent p.a. while oil GDP is estimated to grow at a rate of 5.6 per cent p.a. The plan for growth of the oil sector is based on increasing the export of refined products while oil price expectation remained the same during the fourth plan. Table (2.12) shows the sectoral growth rate. The

manufacturing sector (excluding petrochemicals) is expected to achieve the highest growth rate of 10.5 per cent. Government incentives and various facilities are conclusive factors in the attainment of the projected growth rate in this sector. Agriculture is also estimated to grow at a rate of 6.0 per cent less than the actual growth rate in the third plan. This growth, however, is based on the assumption of increased productivity in this sector.

Concerning human resources development, SR 135.5 or 26 per cent of total plan expenditures had been allocated to the development of human resources through education and vocational training which, in the end, resulted in increasing the productivity of the Saudi workers. The planners during the fourth plan hoped to increase the Saudi labour force by 375,500 which entailed a 600,000 reduction in the number of expatriate workers during the five years of the plan. Total employment, however, is expected to decline by 1.1 per cent and most of this decline is expected to be in construction and trade sectors.

In contrast to the productive sectors' allocation, expenditures on transport and communications, municipalities and housing sectors were less than in the previous plan. The reason for this decline is due to the fact that the kingdom had completed most of its major infrastructure projects during the last three plans.

The projected revenue of the fourth plan is estimated at SR 200 billion a year, most of which is

TABLE 2.12

COMPOUND ANNUAL GROWTH RATES
IN GDP, PRODUCTIVITY AND EMPLOYMENT
DURING 1985 - 1990.
(Per cent per year based on 1980 prices).

NON-OIL GDP

	EMPLOYMENT	GROWTH RATE	PRODUCTIVITY
PRODUCTIVE SECTORS	-1.3	3.3	4.6
AGRICULTURE	1.4	6.0	4.5
OTHER MINING	0.4	3.0	2.6
OTHER MANUFACTURING (excluding petrochemicals)	5.2	10.5	5.0
Electricity, gas and water	0.0	5.0	5.0
Construction	(-8.1)	(-2.8)	5.8
Service Sectors	(-0.8)	3.8	3.6
Trade, restaurants and Hotels	(-2.4)	2.5	5.0
Transport, storage and Communications	(0.5)	5.0	4.5
Property	(-2.6)	0.0	2.7
Finance,Insurance, Business and Services	0.9	9.0	8.0
Community, Social and Personal Services	(-0.5)	3.5	4.0
Government	(-1.0)	0.0	1.0
Total Average for non-oil economy	(-1.0)	2.9	4.0

Source: Ministry of Planning in Saudi Arabia ,The Fourth Development Plan, p. 122.

expected to come from oil exports. Other revenues are expected to arise from investment abroad and local revenue which alone expected to be around SR 20 billion.

At the beginning of the third plan, total exports, mainly oil, represented 67% of the total gross domestic products at current prices. During the last five years, exports were reduced to 42% of the total GDP.

Imports, with respect to non-oil GDP, however, represented a very high percentage in 1980; 99%. This

percentage was, however, reduced to 72% in 1985 as a result of an increase in non-oil GDP. Planners, in the fourth plan expected to reduce the percentage of exports to gross domestic product by only 2.0 per cent in 1990 i.e. to 40% per cent. Concerning the relationship between imports and non-oil GDP, the percentage change of imports to non-oil GDP is expected to be reduced from 72% in 1985 to 50% in 1990.

It remains to be seen whether the fourth plan is going to achieve the projected targets, especially when one considers the fluctuations in the oil market which result in a very low price level; namely $10 per barrel.

2.2 The Effect of Oil Revenue on the Saudi Balance of Payments:

The financial impact of oil price increases in 1973 and 1979 created the temporary phenomenon of oil surplus funds in Saudi Arabia. The Saudi Arabian Monetary Agency estimated the assets at SR 266.45 bn ($80.37 bn at the prevailing exchange rate). It was believed that Saudi surplus funds would rise to $118 bn by the end of 1980. By early 1981, Morgan Guaranty Trust Company's estimated that the kingdom's net external assets would become $132 bn by the end of the same year.[11]

The Saudi current account, however, experienced a deficit during the 1960s, since oil prices and production policy were under the control of

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11 Financial Time Survey About Saudi Arabia ,Tuesday ,May 5 1981.

multi-national oil companies. Oil revenue was very low due to the low level of oil prices. Government revenue was too small to meet the whole government expenditure. The situation, however, changed rapidly during the 1970s. Oil prices quadrupled in 1973 and this led to a current account surplus. Apart from oil price increases, the government managed to reach a participation agreement with the oil companies in 1972 according to which the government gained control of 25.0 per cent of the oil companies' assets rising to 51 per cent in 1983. Thus, increasing oil prices during the period 1973-1979 resulted in a huge financial surplus for the Saudi economy which encouraged them to launch very ambitious and expensive development programmes, as was mentioned previously.

As a result of this, the kingdom has increased its imports from the OECD and non-developed countries by 82 per cent in 1973 over the previous year.[12]

Having increased the size of imports, it is argued that most of the oil revenue would pour into the industrial countries as a payment for these imports. In addition, payments for foreign services would increase as long as Saudi Arabia and the developing countries alike required foreign assistants to execute their development plans.

Despite all these factors, in addition to inflation, huge surplus funds were being accumulated in

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12 Y.A. Al-Awadi, OPEC Surplus Funds and Investment Strategy of Kuwait, Ph.D. Dissertation, University of Colorado, 1975, p. 123.

Saudi Arabia and Kuwait. The Saudi government was very sensitive about those amounts of foreign assets that have emerged recently, since the value of those assets has been eroded due to the exchange rate fluctuations of the dollar and the pound sterling and the rate of inflation.

The government policy, however, was to invest most of their assets in the short and medium term. The government would like to keep its assets in a liquid and accessible form. Sheikh Abdel-Aziz Al-Quarishi former governor of SAMA said "we want to have our money when we need it".[13]

Saudi future surplus, however, will be affected by the following factors:[14]

1. The volume of oil exports and the future demand for oil.
2. Government revenue per barrel.
3. The volume and price of imports.
4. The government attitude towards foreign aid.
5. The rate of return on foreign investment.

The first two factors can be summarised by the fact that oil is the main source of Saudi income. As has been previously mentioned, demand for oil is very difficult to predict. The Saudi government, therefore, kept some of its assets in liquid form in order to protect against any kind of decline in petroleum revenues.

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13 Financial Times April 26th 1982.

14 R. El-Malakh, Saudi Arabia Rush to Development, Croom Helm, London and Camberra, 1982, p. 359.

The Saudi future funds will be affected by the size and price of imports. Since the price of oil increased the price of imported goods increased as well, especially during the late 1970s.15

If the oil market, however, witnesses another set-back in its demand, and the prices of the imported commodities maintain the same trend, Saudi reserves will have to be reduced in order to meet the government's financial requirements.

Concerning foreign aid and grants, Saudi Arabia during the 1970s had increased its regional aid within the Arab world. Apart from the financial assistance to other Arab countries, the kingdom contributed grants and aids to most financial organizations such as the World Bank, the International Monetary Fund and other organizations. One billion dollars was contributed as aid to African countries through the Arab Bank for Economic Development. The Saudi aid was useful in the development of non-oil producing countries. Oil-producing countries were also helped. Saudi Arabian loans and aid to Iraq, for example, were crucial in the stand against Iranian attacks. The future of Saudi aid, however, will depend heavily on the volume of oil exports and the government's revenue (from this).

The controversial point is the size and the type of investment of the Saudi funds. Those funds imply a transfer of income from oil- importing countries to oil-exporting countries. It has been recently alleged that

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15 International Monetary Funds, International Financial Statistics, September 1977, December 1979.

such a large transfer of purchasing power from the industrial countries to the Saudi economy would create a transfer problem that might cause an instability in the international economy and the international financial system, since recycling of these surplus funds requires a generation of additional expenditure to absorb those financial resources. Thus, the Saudi and the Kuwaiti surpluses have created a balance of payments problem in the West.

It is argued, however, that Saudi Arabia, by investing its assets abroad, tried to secure the future development of the country since oil is an exhaustible resource which will be depleted in the foreseable future.

Having briefly explained the Saudi surplus funds, it is worth mentioning here the effects of those funds on the exchange rate. To discuss the effect of a balance of payments surplus on the exchange rate in Saudi Arabia, it is more convenient to discuss a relatively similar case of those countries which experienced a sudden boost in their economies such as Holland and the U.K.

Great Britain was one of the world's leading exporters at the beginning of this century. British industries and their economic growth, however, have declined due to many factors. Among those factors was the increasing competition of other European countries in addition to America and Japan, which resulted in a decline in demand for U.K. manufactured goods.

Exchange rate fluctuations can be added to those

factors which worsened the industrial situation. North Sea oil, however, has not helped the industrial sector as much as it was expected. Although North Sea oil attracted foreign capital which strengthened the British economy and cured the balance of payments problem, it increased the exchange rate of the pound sterling due to a rise in the demand for the pound. Those factors (ie. capital inflow and oil production) have helped to appreciate the exchange rate of the pound with respect to other currencies. Consequently, British exports became more expensive and relatively less competitive. British manufactured goods, therefore, decreased and unemployment has risen due to an increased dependency on foreign manufactured goods since imports became cheaper with respect to the exchange rate of the pound.

In the case of Netherlands, the development of natural gas in the late sixties and seventies, led to a similar problem which was called the "Dutch disease". The Dutch government increased its public expenditure on consumption due to a high revenue generated from exporting natural gas. The exchange rate of Dutch Guilder rose and so did the imports of manufactured goods since imports became relatively cheaper in terms of exchange rate. These factors affected the Dutch industrial sector in such a way that production was reduced which in turn affected the rate of employment. The question that might face the Dutch government is how to maintain the same level of public expenditure on consumption when the natural gas is depleted. There is a need, therefore, to adopt a wise policy to utilise those

depleted resources.

Thus, "Dutch disease" is a phenomenon which describes those economies which are enjoying booms along-side with lagging traded-goods industries or sectors.

For example, increasing the price of one exportable commodity would result in a real exchange rate appreciation and a relative fall in the prices of other tradables.

The period of the 1970s has witnessed the prevailance of the flexible exchange rate, world-wide inflation and increases in oil prices which all affect the terms of trade.

In 1973, the price of crude oil increased dramatically which positively affected the Saudi balance of payments and its exchange rate. Continuous oil price increases in 1977, 1979 and 1980, have created a shift in the terms of trade as well as an income transfer from the rest of the world to OPEC and the main producers of the manufactured goods. Some crude oil importers, however, have suffered a balance of payments deficit. Most of them have adopted a deflationary policy due to prevailance of unemployment and inflation.

Oil price increases, on the other hand, have increased government revenue and money supply causing inflation in Saudi Arabia.

Buiter and Purvis (1980) have argued that an oil increase would generate different effects on permanent real income, depending on whether a country is a net exporter or a net importer.[16]

In the case of the net exporter, the exchange rate should appreciate in the long run, due to a balance of payments surplus.

In the short run, it can either appreciate or depreciate depending on whether the output of the domestically produced non-traded goods is more responsive to the foreign price of oil or to the real exchange rate. When the exchange rate appreciates, domestic output will be reduced and Dutch disease will prevail.

In the case of the net oil importer, an oil price increase will depreciate the exchange rate in the long term.

The application of the "Dutch disease" phenomenon to the Saudi economy is arguable. The U.K. and the Netherlands are developed countries and their share of manufactured traded goods in the international market is very high compared with Saudi Arabia. In addition, North Sea oil and natural gas production occurred whilst these countries were already industrialised and the exchange rate appreciation affected their industries as they became less competitive in the international market in terms of the price level and foreign exchange.

Unlike Holland and Britain, Saudi Arabia is still a developing country. It is a tribal and religious society and until the end of 1960s the government experienced a balance of payments deficit. Although oil price

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16 W.M.Biuter and D. Purvis, Oil Disinflation and Export Competitiveness:A Model of The " Dutch Disease ", Discussion Paper 6180, October 1980.

increases in 1973 have helped the government to set up development programmes, industry in general is still in its infant state. Even if Saudi Arabia is able to produce some kind of manufactured goods for export in the near future, marketing could be a problem. Successful industry in Saudi Arabia requires regional cooperation amongst the Gulf States and Arab countries in general in order to create the demand for its products. Such cooperation might be possible among the Gulf States and those countries which receive financial aid from Saudi Arabia such as Pakistan, some of the North African countries and Jordan, but it is unlikely to happen with some radical Arab countries due to a different political ideology and institutional structure. Apart from that, the revenue from exporting crude oil has created a balance of payments surplus which appreciates the Saudi's Riyal exchange rate, yet this appreciation is of a different kind, since oil is evaluated by U.S.A. dollars in the international market and hence any fluctuations in the dollar would affect the government revenue in turn.

It remains to be seen, however, whether the application of the "Dutch disease" phenomenon will become viable when the country reaches the standards of the U.K. and the Netherlands in terms of development.

CHAPTER THREE

THE ROLE OF FOREIGN INVESTMENT IN DEVELOPING OIL RESOURCES IN SAUDI ARABIA

The aim of this chapter is to examine the initial concession agreements between the Kingdom and the multi-national oil companies. In doing so, a light will be shed on the relationship between the partners concerned; the changing hands of investment decisions and the development of income tax and royalties throughout the agreement.

The role of foreign investment and its impact on the developing countries has been the subject of much heated debate in the literature of Economic Development. [1] Nowhere is this debate more intensified than in the oil companies' operations in the oil- producing countries especially in the era of the oil price increases of 1973-74.

In the developing countries, the coincidence of lack of foreign exchange and technological know-how have combined to form one of the most formidable barriers to economic growth and development.[2] The role the

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[1] See P. Streeten `The multinational Enterprise and the Theory of Development Policy' - World Development, Vol. 1, No 10, 1973,pp.1-14 ; R.J. Ball, `Capital Imports and Economic Development: Paradoxy or Orthodoxy', Kyklos, No 3, 1962,pp.610-623; S. Lall,' LDCS and Private Foreign direct Investment: A Review Article', World Development, Vol 2, Nos 4,5 (1974).

multinational corporations were expected to play, is very much intertwined with their definitions. A multinational company is an organisation which transcends national boundaries to locate in a host country while its parent body is in another country. Organisationally they all have in common the main objective of making profits. In their quest for profits, they are said to use the best and efficient means of production which infuses huge financial capital and technology into the host country. Compared with other forms of aid towards self-sustained development, this offers the best hopes because of the dynamic effects in encouraging an export_ orientated strategy of industrialization and also by providing the opportunity for technical awareness to grow as"learning-by-doing" would foster industrial organisational discipline in the labour force.

Over the years, experience has shown that these expectations may have been raised too high as the skill contents of transferred technologies have become negligible. This is the case since the operations of these corporations, because of the intense competition and rivalry between them, have designed and operated

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[2] M. El Shibley and A.P. Thirwall, `Dual Gap Analysis for the Sudan´ in World Development, Feb. 1981,pp.193-200; also H. Chinery and A. Strout `Foreign Assistance and Economic Development´ American Economic Review, Sept. 1966,pp.679-733, E. T. Penrose, The Growth of Firms, Middle East Oil and Other Essays, Frank Cass and Company, London, 1971, Section I and II; Also, E. T. Penrose, ed., The large International Firm in Developing Countries, The International Petroleum Industry, George Allen and Unwin Ltd., London, 1968, Chapter,1, 2, 7, 8, and 10.

with specialized and often personalised technology making it highly capital- intensive and automated, thus possessing little skill content. Also criticisms have been levelled against these corporations for the enormous power they possess because of their horizontal and vertical integrational modes of operations. This would leave their host countries with little bargaining power, forming a relationship which is sub-servient in character to the detriment of the host countries. Such arguments have been put forward as the main motive behind the wave of nationalization that characterised the oil industry in the 1970's.

On the other hand, multinational oil companies have also come under attack from their home- based group members for concentrating solely on profits with little concern for the global economic consequences, especially in the volume of world trade. This accusation became prominent in the advent of the oil price increases.

The oil multi-nationals were thus accused of colluding with OPEC countries to push up the oil price which would raise their profit margins. This was certainly the view of Adelman when he referred to the oil companies as agents of foreign power. This view was supported by the Saudi Arabian oil minister when he described the relationship between OPEC and oil multinational corporations as a participation which provides a reasonable profit for both "So long as they (the companies) are able to continue making a decent profit, they should be only too glad to remain with us, particularly in the sort of stable investment climate we

have in Saudi Arabia."[3]

With the OPEC countries, there were other accusations levied at oil multi-national corporations. The so-called 'Seven Sisters' abilities to dictate how much to produce and where to fix the price have kept oil prices below their competitive real value, denying OPEC a substantial revenue source. The effects of this on the economy of OPEC was to be seen in the vulnerability of their economies to the diminishing oil revenue. The need to reduce and mitigate such fluctuations and correct the inequity of oil concessions agreements which favoured the oil companies led to the formation of OPEC.

Whatever the strength in these arguments, the role of the oil companies in the development of OPEC economics is invaluable and cannot be doubted. Firstly, without the cooperation of the oil companies, OPEC could not have been formed. The assessment of the role of the oil companies must stem from whether or not countries like Saudi Arabia and others did benefit from OPEC formation and the subsequent increase in their income revenue. It is hard to uphold any agreement that would contradict the afore - mentioned point. The so _ called "OPEC-companies mechanism" relationship between the oil companies and OPEC in determining both output and prices, a mechanism very much used to influence each others decisions, do help to stabilize prices during the

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[3] Middle East Economic Survey, May 17, 1968. Also, Detailed Discussion of This and Other Related Views Can be Seen Reflected in Sam, H. Schurr and Paul, T. Homan, Middle East Oil and The Western World, Prospect and Problems, American Elsevier Publishing Company, INC.,USA, England and Neyherland, 1971, Chapter; 11.

sixties and early seventies.

3.1 The Concession Agreement of 1933

Oil industry is capital intensive in a sense that in all stages it requires capital and the know-how which were unavailable in developing countries and Saudi Arabia alike at the time when all concession agreements were assigned to foreign oil companies.

In May 1933 an initial concession agreement was reached between the Saudi Government and the Standard Oil Company which assigned it to the California Arabian Standard Oil Company. In 1936 the Texas Corporation took on a half interest in the above mentioned company. The name of the company, however, was changed to the Arabian American Oil Company which also included New Jersey and Socany Mobil Oil Company.[4]

According to the initial agreement, the kingdom would earn 4 shillings (gold) per ton or US$ 0.22 per barrel and £5000 (gold) as an annual rent which was extended to £140,000 (gold) after the discovery of oil in 1939. [5]

Concerning the initial concession agreements, one would predict a weak position of the host government due

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[4] 30% of each of the three companies, Standard Oil Company of California, Texas Company and New Jersey and 10% for Socany Mobil.

[5] The aim in considering the initial agreement is to look at the development of prices and income tax only, for further details refer to Donald A. Wells, Aramco: the Evolution of an Oil Concession,in Raymond F. Mikesell,ed., Foreign Investment in the Petroleum and Mineral Industries, The John Hopkins Press, Baltimore and London 1971.

to many factors such as the government's urgent need of revenue necessary to change the tribal society to a modern state. The sole government revenue at that time was the funds received from pilgrims which was declining due to the worldwide recession in 1930. With these factors in mind, we would expect the host government, being in a weak position, to accept any offer from the oil companies.

From the oil companies' point of view, it was a great adventure to be involved in such deals which had to provide the funds necessary for the entire operation in the short and long term. What made it worse was that no-one had any firm idea that oil could be found in such a desert and if found whether it could be of any significant commercial quantity. Thus the oil companies were confronted with considerable risks had the oil not been discovered in Saudi Arabia.

After the discovery of oil in Saudi Arabia and the Middle East area, the oil companies took control of production, pricing and marketing policies and most of the profits went to the integrated "Seven Sisters" who upto 1950 effectively cartelized the oil market.[6] This, however, emerged from the fact that the host governments were only interested in the revenue necessary for their financial requirements. Moreover, conservation policy and "limit to growth" phenomena did not exist in their policy. With these factors in mind, one would not be

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[6] The "seven sisters" are: Mobil, Texaco, Standard Oil company of California, Gulf, Royal Dutch-Shell, Exxon and British Petroleum (BP).

surprised if the oil companies managed to keep the price down for their own interests.

Prior to 1950 the price of oil was determined by a basing-point system. The price of oil in the U.S. Gulf of Mexico determined the price of oil all over the world. This was due to the emergence of the Gulf of Mexico area of the United States as a main source of oil supply while the Middle Eastern oil was yet to be acknowledged. The price of Middle East oil was, therefore, offered at the Texas Gulf price plus the cost of freight from the Texas Gulf to the final destination even though the production cost and the freight charges would have been different.[7]

The basing-point system, however, was a collusive act amongst the integrated oil companies to reap the benefits of the oil industry by introducing an identical price system for a different market irrespective of the origin. The reasoning behind the introduction of such a system was to avoid any competition amongst sellers and to avert any individual action that would disturb the stability of the oil market.

At the end of 1949, the company's profit from selling the Arabian Gulf oil in Europe according to the basing-point system was estimated at around 68 cents per barrel.[8]

The situation, however, was not to remain as stable

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[7] C. Issawi and M. Yeganeh, the Economics of Middle Eastern Oil, New York: Frederick A. Praeger, Inc. 1962, pp64-65.

[8] M.A. Adelman, The World Petroleum Market, the John Hopkins University Press, Baltimore and London, 1972, p.136.

as the "seven sisters" would have preferred it to be since dramatic changes occurred in the international oil market in the early 1950s which improved the bargaining position of the host governments in terms of prices and royalties.

3.2 Changing Role of the "Seven Sisters"

During and after the Second World War the Middle East area emerged as a large supplier of crude oil. Faced with this fact, the oil companies were forced to change the "basing-point" system by introducing the "posted prices" of the Middle East for the first time in 1950. Although the price of Middle Eastern oil was practically identical to Texas prices, but income tax was introduced instead of fixed royalties per ton which gave the governments 50 per cent of profits.[9]

The system of "posted prices" remained fairly stable until 1956 reflecting the balance between supply and demand. The "posted prices" system, however, came under pressure after opening the Suez Canal coupled with the imposition of petroleum import quotas by the U.S. government. In addition, the Soviet Union increased its share of the market which resulted in glut in the international oil market. Also of importance were the sales of the new independent state-owned oil companies which entered the market and eroded the power of the major oil companies. The French, Italian and Japanese

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[9] J.E. Hartshorn, Oil companies and Governments, London, Faber & Faber, 1962 p.137.

governments managed to construct and finance independent oil companies which engaged in the production, purchasing and marketing of crude oil and its products. These combined factors increased competition in the market which resulted in a surplus of oil and in turn falling posted prices. Thus, for example, the posted price of Arabian light crude fell from $2.08 in June 1957 to $1.90 in February 1959 which was followed by a further decline to $1.76 in August 1960.10

The decision to reduce oil prices was taken unilaterally by the oil companies which provoked the formation of OPEC in September 1960. The main objective of OPEC was to prevent any further reduction in posted prices and apparently OPEC was successful in achieving this since posted prices were frozen until the Teheran and Tripoli agreements in 1971. Thus the major issue which concerned Saudi Arabia and the oil producers (except U.S.A.) was the maintenance of posted prices , if not the raising of these prices. Saudi Arabia, for example, relied heavily on the amicable solution to settle any conflict between the government and the oil companies.

After a certain development in the initial concession agreement between the Saudi government and the oil companies, the initial payments consisted of the following items:

(a) Income tax as 50 per cent of profit, where profit per barrel was equal to price minus cost of production.

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10 Donald A. Wells, op.cit., p.221.

(b) Royalties in kind or costs equal to 12.5% of the net price which was included in income tax.

(c) Plus bonus payment and annual rent during the period of exploration.

Obviously royalties were treated as an income tax liability rather than a cost. Oil producers in the Middle East, however, were determined to treat royalties as costs as it was a rent to the host government for using its exhaustible resource regardless of whether any net profits were made during the process of production.[11] As a result, an agreement was reached between the oil producers and the oil companies to consider royalties as an expense and not as a credit against tax. Accordingly the government revenue per barrel was increased from $0.80 to $0.9125.[12]

It is still important to emphasise the fact that after ten years of existence, OPEC had done only a little for oil producers. What happened in the oil market by the end of the 1960's and early seventies was independent of OPEC. In other words the major oil companies still held the control of the oil market in terms of price and production. Professor Penrose, in 1969, was therefore right to quote that "OPEC has never been as powerful in the international oil industry generally as were the major companies in their hey days".[13]

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11 Z. Mikdashi, the Community of Oil Exporting Countries A study in Governmental Cooperation, New York, Cornell University Press, 1972, p.143.

12 OPEC, Annual Review and Record, 1970, p.21.

The glamorous years of the major companies, however, began to fade gradually and important features occurred in the energy market by the end of the Sixties and early Seventies which eroded the power of the Seven Sisters and created a turning point in the relationship between the oil producers and the oil companies.

Professor Penrose correctly predicted that the power of the major companies was negatively correlated with increasing their revenue. She also expected OPEC to be more successful in the future bearing in mind the fact that host governments had realised the size of profits that the major companies earned from the oil industry.

Analysing the developments in the oil market would permit the reader to conclude whether OPEC was behind the changes that occurred in the market or whether these changes were caused by other factors. Although Penrose predicted the changes, OPEC was not the cause as is shown by examining these changes in detail.

First of all, the demand for crude oil and oil products increased rapidly in Western Europe in 1969-70 which, in turn, made North African oil more valuable due to its proximity to the European oil market, and its suitability for refining. In addition, the closure of the Suez Canal brought about by the Arab-Israeli war in 1967 coupled with the periodic interruption of the Trans-Arabian pipeline which was finally closed by Syria

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13 E.T.Penrose,Petroleum Industry,Hearings before the subcommitte on Antitrust and Monopoly of the Committee on the Judiciary, U.S Senate,91st Congress,1st Session, Part One,pp.432_33.

in 1970, have encouraged the West to depend on oil fields in North Africa at least in the short term, bearing in mind the shortage of tankers which made the freight rate surge after the closure of the Canal.

Helped by these factors, Libya took the initiative amongst the North Africa and Arabian Gulf oil producers and negotiated with oil companies to increase income tax and royalties in January 1970. Ghadaffi, the new leader, a zealous and pro-Arab figure ordered a cutback in output for all oil companies operating there as a measure to increase the burden on the oil companies. Oxy, for example, were forced to cut output by more than 50 per cent. Other companies who had concessions in the Arabian Gulf suffered less, but the problem that faced oil companies was more than the Libyian demand. Had the companies come to terms with Libya, other oil producers in the Arabian Gulf would have followed suit. The oil companies, however, were aware of the problem and they realised that should they respond to the Libyan demand the same increase should apply to other oil producers in the Gulf as they would try to outdo Libya. In addition to the economic consideration, a political factor would be another reason for some oil producers, such as Iran, Saudi Arabia and Kuwait, to negotiate the Libyan gains. The radical governments such as Iraq and Algeria strongly supported Libya as they were convinced that posted prices were less than the real ones and the government taking per barrel were less than the profit assigned to the major companies. Algeria, for example, had already taken over the operation of selected oil

companies and by July 1970 income tax on the French companies was raised to 72 per cent per barrel without any prior consultation.

Iraq, on the other hand, had also started to negotiate with the Iraqi petroleum companies which ended in nationalizing all IPC in June 1972.

The Libyan demand, however, was met and consequently posted prices of 40-degree API Libyan crude were increased by 30 cents per barrel. Income tax was also raised to 55 per cent with retrospect to previous years.[14]

The Arabian Gulf producers demanded and received 20 cents per barrel for the Saudi and the Iraqi crude oil exported through the Mediterranean whereas the same increase of income tax was applied to all oil producers.[15]

It is argued, however, that the effects of the Libyan cut- back on the international oil market was small and the major companies could have done without the Libyan crude oil.[16] It is true, but the meeting of the Libyan demand was helped by the above and the following factors: most of the Libyan oil was produced by small independent oil companies who had no alternative sources of supply to honour their previous contracts and to keep their refineries in operation.[17] Also important was the quality of Libyan crude; low-

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14 E.T. Penrose,' The Development of Crisis,' Daedalus (Fall 1975) Vol. 104, p.40.
15 OPEC, Annual Review and Record, 1970, p.21.
16 M. Adelman (1972) , op.cit., p.251.
17 E.T. Penrose (1975), op.cit., p.41-42.

sulphur which complied with the environmentalists' demands and public concern in Europe about the effects of pollution.

The oil companies, however, came to realise that they had no choice but to accept the Libyan demand. J.E. Akins, the oil expert(at that time) in the state department explained that "a top official of a major oil company seriously urged the American government to dare the Libyans to nationalize; if they did, the Europeans would then be told they would have to tighten their belts".[18]

The intention of the major companies was to prevent Libya from exporting crude oil. The "top official" was confronted with the fact that the Libyan government had $2 billion in currency reserves that would keep it going at current levels of expenditure for four years. The state department also realised that it would be very difficult to persuade the state-owned oil companies (European and Japanese) to put Libya on the black list. Leaving aside the state-owned companies, it was very unlikely that their governments could be persuaded in the first place.

Professor Adelman, however, put the blame on the state department for being pro-oil producers or pro-Arabs. The oil price increases, according to his view, would have been prevented, had the oil companies adopted a cooperation policy and adopted a collective action against Libya. His argument, however, seemed to

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18 J.E. Akins' The Oil Crisis: This Time The Wolf Is Here', Foreign Affairs, 51, 1972-73, p.471.

be based on the weak bargaining position of individual oil producer. What had been ignored by Adelman, was the fact that the U.S. policy was aimed at political stability in the Middle East, since the U.S. demand for crude oil was increased in 1970, most of which was satisfied through imported oil from the Middle East. Also important was the prevention of the influence of the communist block especially Russia, supported by radical forces in the area. With these factors in mind, the state department seemed to favour the oil producers' demands as a mean to maintaining the U.S. interests in the area.

Nevertheless, what happened was an indication of the erosion of power of the major companies and the increasing bargaining position of the oil producers. This can be expressed by OPEC's new demand to increase prices and income tax rate on the grounds of stabilizing the oil market. Had the demands not been met, OPEC oil production would have been stopped and the companies would then have had to face the wrath of the consuming countries. This had been expressed in Teheran in 1971 during the negotiations between oil producers and oil companies. The gap between both sides was very wide but eventually a settlement was reached in Teheran in February 1971 according to which oil prices increased by 45 cents per barrel for the Gulf price with a schedule for further increases through 1975.[19]

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19 I. bid. p.473. Also full details of the Teheran Agreement can be found in The Middle East Economic Survey, Supplement, vol XIV, No 17, 19 February, 1971.

Libya, however, was negotiating with the oil companies on behalf of the North African oil producers and an agreement was reached to raise posted prices from $2.55 to $3.44 per barrel for 40 API crude oil.[20] The agreement also cleared all government claims retrospective to the period prior to the signing of the agreements.

The aim of the Teheran and Tripoli agreements was to stabilize the revenue of the oil producers and oil supplies to the oil companies. The effects of the above agreements were not long-lasting since by the summer of 1971 the exchange rate of the dollar had depreciated in relation to other European currencies and the suspension of the U.S. Dollar-Gold convertability. Also important was the inflation rate which was around 9 per cent in Europe and USA at that time. In the light of these factors, OPEC demanded compensation from the oil companies and, in January 1972 an agreement was reached between OPEC and the oil companies to raise posted prices by 8.49 per cent. With a further devaluation of the dollar, oil producers had managed to reach another agreement called Geneva Two which compensated for the loss in the revenue from dollar devaluation in 1973 and it was also an edge against future devaluation.

By October 1973, the posted price of the Arabian light crude increased from $1.80 per barrel in 1971 to $11.65 per barrel in January 1974. Thus the oil market had undergone dramatic changes in terms of the changing

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20 MEES, Supplement, vol. XIV, No 24, 9 April 1971 pp.1-5.

role of the governments of oil producers in determining the size of their revenue. After a further development of posted prices, OPEC abandoned the posted price system and adopted a new system based on the "average government take from the operating oil companies" of $10.12 for the Arabian light marker crude.[21]

Before the first oil price increase in 1973-74, Arab oil producers, however, were divided into two groups, the conservative and the radical ones. Iraq, Libya and Algeria were hoping that all Arab producers would nationalize the whole oil industry and eventually they did so; while the conservative group, Saudi Arabia and Kuwait preferred to do otherwise, namely the participation agreement, according to which the government would acquire a percentage share of 25 per cent of the companies assets rising to 51 per cent in 1983.

In concluding this section we have shown that the power of the major companies was changed from one of controlling prices and production policies to one of being an agent for the host government. Despite these changes, the role of the major companies was very significant in developing oil resources in Saudi Arabia in a sense that the kingdom earned huge amounts of financial resources from oil exports already being developed by multinational oil companies.

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[21] Full details of the oil price development after 1973 can be found in MEES, supplement 15 November 1975, pp.1-5; MEES, supplement, 13 December 1974, p.1 and also in The Petroleum Economist, vol XLII, No I, January, 1975 p.13. The remainder of the oil price evolution will be discussed in Chapter 6.

According to Paul Streeten, Saudi Arabia for many centuries sat on the oil deposits and reserves without knowing that they existed. Assuming it did, due to the lack of technological know-how and the huge capital investment required relative to the impoverished economy prior to the oil boom, the resources would still not have been exploited.

The word `investment' in the oil industry means extensive amounts of money which have to be spent to find and develop oil reserves. In every sense this does not constitute a `Fixed Asset' for the industry nor a sum invested in productive facilities for other industries because of the huge risk involved and in the case of failure these sums of money are written off as losses. This involves an expensive business as indicated in the World Bank's Study in 1961 to be US$5000 for a barrel as an extraction cost.[22] The Chase Manhattan Bank estimated that it would probably require about $140 billion to produce the oil necessary to meet the demand in the free world between 1960 and 1970.[23] The United States Department of Commerce survey of American investment abroad in 1961 put the book value of capital investment in the American Petroleum business in the Middle East for 1960 at $1.2 billion.[24]

Apart from the direct investment in explorations there are other huge costs associated with development, production, transport and marketing. About 2/3 of the US

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22 J.E. Hartshorn, op.cit., p.91.
23 J.E. Hartshorn, op.cit., p.94.
24 J.E. Hartshorn op.cit., p. 99.

capital expenditure in oil exploration between 1950and 1960 went into exploration development and production, 13% into refineries and petrochemicals, about 6% into transport and another 6% into marketing facilities.[25] From the above analysis, oil is a business which involves a very extensive capital outlay.

Although the capital outlay required in the case of Saudi Arabia may not be exactly the same as that of the United States, it is, however, significant. Table (3.1) shows the capital expenditures required for oil development in Saudi Arabia.

TABLE 3.1

OIL DEVELOPMENT CAPITAL EXPENDITURES, SAUDI ARABIA

1947-1967 (US$ million)

1947	52.8	1954	11.6	1961	27.7
1948	67.0	1955	5.0	1962	23.2
1949	37.6	1956	17.0	1963	9.8
1950	17.6	1957	28.8	1964	21.0
1951	21.2	1958	31.6	1965	27.5
1952	48.3	1959	16.6	1966	33.2
1953	26.5	1960	15.6	1967	34.5

Source:M. Adelman, op. cit. p. 305

In the above table the development of capital expenditure for Saudi Arabia is well documented. One critical element is that up to 1974, the Saudi economy was relatively backward and other sources of foreign exchange for the importation of capital investment goods were negligible and scarce. We would not be far from the truth in saying that virtually all the capital needed

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25 J.E. Hartshorn, op.cit.,p.89-90.

for investment in this period was provided by the oil multi-nationals. Accompanying this were the management and technical experts highly desired by the industry for its operation.

When, in 1973/74 the Saudis took control of the oil industry from the oil companies, this was a theatrical cosmetic change- over as both the management and staffs of the oil companies still retained their jobs because of the inability of the Saudis to provide domestic replacements.[26] Also, this era was characterised by joint ventures between the government and the oil companies. Among such ventures were SUBIC/EXXON which was instructed to produce 240,000 metric tons of low-density polyethylene annually at a cost of $1 billion. JUBAIL SUBIC/PECTEN ARABIA Limited (belonging to the Shell Oil Company) is another example of a joint venture to develop a petrochemical plant whose products would feed the SUBIC/EXXON plant at a cost of US$4 billion; and also SUBIC/MOBIL plant to produce 200,000 metric tons of ethyleneglycol.

The role of the oil companies became even more important in the marketing of oil and its products. As mentioned above, although there was Saudi diversification into petrochemicals it was still the oil companies who would buy these products as an intermediate input into the production of finished goods that would be sold under the companies brand names. Were Saudi Arabia to produce these goods and put them

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26 Morris Adelman, op.cit., p.257.

onto the market, this would be difficult as the oil companies controlled virtually all market outlets. It would be exceedingly difficult for the Saudi product to compete with already established brands backed up with successful and expensive advertising.

Quite contrary to the role often ascribed to the oil multi-nationals in the developing countries using the Saudi experience, we have demonstrated that they indeed play important roles in the development of the host countries' economics. Although the relationship between the oil multi-national corporations and their host governments is not as favourable as it once was , there is no question that there is a mutual benefit in their association. On the basis of the above analysis, we would conclude that foreign direct investments through the oil companies have played a significant role in providing the very necessary initial capital required in the development of the oil sector which benefitted the whole of Saudi Arabia's economy.

CHAPTER FOUR

DEPLETION THEORY OF EXHAUSTIBLE RESOURCES

Some natural resources such as oil are exhaustible over a long period of time. Cheap oil prices during the 1950s and 1960s encouraged the world to depend heavily upon oil which led to a rapid depletion of world resources. Natural resources, however, in general, have been overused and rapidly exploited throughout the nineteenth and the twentieth centuries.

In this literature, the aim is to examine if the world's natural resources are being depleted too rapidly or too slowly (i.e. are we depleting the world exhaustible resources at the optimum rate over time). The discussion, therefore, will consist of three basic points:-

Firstly: The theory of natural resource depletion;

Secondly: Depletion of oil resource;

Thirdly: Market imperfections and the rate of depletion as an obstacle in achieving optimization.

4.1 The Theory of Natural Resource Depletion

H. Hotelling was the first economist to develop a theory of natural resources depletion in 1931. He quoted "Contemplation of the world's disappearing supplies of minerals, forest, and other exhaustible

assets has led to demands for regulation of their exploitation. The feeling that these products are now too cheap for the good of future generations; that they are being selfishly exploited at too rapid a rate, and then in consequence of their excessive cheapness they are being produced and consumed wastefully has given rise to the conservation movement".[1] Many economists such as Dasgupta and Heal (1979), Adelman (1976), Heal (1975;1976;1981), Heal and Brown (1980), Pindyck (1981), Robinson (1975), and Solow (1974), have tackled this subject due to the importance of exhaustible commodities.

R. M. Solow (1974) has pointed out the fact of natural resource exhaustability and the real threat that might face the world in the near future.[2]

In Hotelling's "Economics of Exhaustible Resources", certain assumptions are made in order to allow the theory to operate. First, the maximizing conditions are established under conditions of perfect competition with constant cost. His second case provides maximizing conditions for monopolistic or competitive firms whose marginal costs rise with the rate of output. His third case introduces the assumption that costs also rise with cumulative production. Then he goes on to analyse several different aspects of the problem.

To illustrate Hotelling's Theory of Exhaustible

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[1] H. Hotelling'The Economics of Exhaustible Resources' The Journal of Political Economy, April 1931,Vol.39, No.2,PP.137-175.

[2] R. M. Solow' The Economics of Resources or The Resources of Economics' American Economics Review, May 1974, Paper and proceedings,pp.1-14.

Resources under Constant Cost, we assume, for simplicity, that resource reserves (R) are fixed and extraction cost (C) is constant. Thus the cumulative rate of production cannot exceed (R)

$$\int_{T_1}^{T_2} q(t)\, d_t \leq R \qquad (1)$$

Depletion takes place when cumulative production equals the total reserve of the resource. The owner of any natural resource, however, might compare his present profit with the one expected in the future and his decision to produce now or in the future will be based on this principle. The resource owner is also assumed to maximise his present value of all his future profits. Therefore:

$$\text{Max NPV} = \int_{T_1}^{T_2} \pi\, [q(t),\, t\,]\, e^{-rt}\, dt \qquad (2)$$

subject to the constraint

$$\int_{T_1}^{T_2} q(t) d_t \leq R$$

By introducing the Lagrangian multiplier, we can write

the above equations as follows:

$$\int_{T_1}^{T_2} \pi[q(t),\ t\ ]e^{-rt}d_t - \lambda \int_{T_1}^{T_2} q(t)d_t - R = 0 \qquad (3)$$

Where:

π = Total Revenue

T_2 = Terminal Date

$q(t)$ = Output

λ = The Lagrangian Multiplier

r = Interest Rate

R = Total Reserves

Determination of the optimal starting point, the output patterns over time and the terminal date yields a solution for the above equation. Differentiation with respect to the Lagrangian multiplier gives us the constraint as another equilibrium condition. The optimal production pattern, however, is determined by the Euler equation of the calculus of variations, and the boundary conditions are that the function (3) attains a stationary value at T_1 and T_2.

By differentiating we obtain:

$$e^{-rt}\frac{d\pi}{dq} = \lambda \qquad (4)$$

After substitution and re-arrangement, with cost assumed to be constant, we obtain:

$$M\ \pi\ (t) = MR\ (t) - MC\ (t) = \lambda e^{rt} \qquad (5)$$

Where

M (π) = Marginal Profits

M (R) = Marginal Revenue

M (C) = Marginal Cost

The conventional second order conditions also apply:

$$\frac{\partial^2 \pi}{\partial q^2} < 0 \text{ and } \frac{\partial^2 R}{\partial q^2} < \frac{\partial^2 C}{\partial q^2}$$

With pure competition, P = MR, therefore, equation (5) becomes:

$$P - MC = \lambda e^{rt} \qquad (6)$$

Scott (1965) considered λe^{rt} as a user cost; a sacrifice of future revenue due to present sales.[3]

To satisfy the condition postulated earlier on, marginal profit must increase over time at a rate equal to the rate of interest, equation (5) may be considered again. Differentiating with respect to the interest rate (r) yields:

$$\frac{dm\pi}{dr} = t\lambda e^{rt} \qquad (7)$$

Both sides are positive, therefore, any positive

variation in interest rate (r) will positively change marginal profit $M\pi$.

$M\pi$, however, is also a royalty earned by the owner of the resource during the extraction period. Under pure competition, royalty equals price less extraction cost and royalties should increase exponentially over the period of extraction until the date of exhaustion. At that date, production and demand are zero. Under a hypothetical condition of perfect competition where each producer and consumer have full knowledge of the present and future market, the optimum rate of depletion will be achieved. This is, however, the case of Pareto Optimality.

4.1.2 Increasing costs to cumulative production

It has been pointed out that throughout the production periods, unit costs of any natural resources would increase over time. For example,the more crude oil that is produced from a certain well, the less natural gas that remains which is necessary to force oil to the surface. Thus, the accumulated production will affect profit, costs and demand for a certain depletable resource.[4]

Let (x) be the cumulative output, (q) current rate of production as a function of the amount already

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[3] A. Scott' Notes on User Costs' Economic Journal, 1953, Vol 63, pp. 368-384.

[4] R.Gordon, Reinterpretation of the Pure Theory of Exhaustion, Journal of Political Economy, 1967,Vol.75,pp.274-285.

produced and (R) the total reserve. The problem also becomes one of maximizing the present value of future profits. Therefore:

$$\text{Max NPV} = \int_{T_1}^{T_2} \pi\,[x(t),\, q(t)]e^{-rt}\, d_t - \lambda\int_{T_1}^{T_2} q(t)d_t - R] \qquad (8)$$

where π is a function of not only current production, but also the cumulative production (x) and (t). Differentiating according to the Euler Equation we get full maximizing conditions:

$$\frac{\partial \pi}{\partial x} = \frac{\partial^2}{\partial q^2} + \frac{\partial^2 \pi}{\partial q^2} * \frac{\partial^2 x}{\partial t^2} + \frac{\partial^2 \pi}{\partial q \partial x} * \frac{\partial x}{\partial t} - \frac{r\partial \pi}{\partial q} \qquad (9)$$

R. Gordon (1967) in his article "A Reinterpretation of the Pure Theory of Exhaustible", showed that the above equation represented an equality between marginal profits and user cost. This was, however, a negative marginal profit as a result of cumulative output and time path effect on costs.[5]

Cummings (1969), in his paper "Some Extensions of the Economic Theory of Exhaustible Resources" , maintains the assumptions of present value profit maximization but points out that there exists an upper limit on the rate of production for the owner of a natural resource and that it becomes more restrictive as resource stocks fall. His equation of the maximization

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[5] A full development of maximizing conditions can be found in Gordon's paper(1967) op.cit.pp. 274-285.

problem is given by:

$$M\pi(o) = M\pi(t)e^{-rt} + \int_{o}^{t} \left[\frac{dn}{dx}(s)e^{-rt} + M(s)\frac{dk}{dx}\right] ds$$

Where $M\pi$ (O) = marginal profits at time zero and $M\pi(t)e^{-rt}$ equals the present value of the change in profits in the future of an incremental change in production at time zero. The rest of the above equation represents the integral discounted costs that might occur in the future due to an incremental change in production at time zero, and they can be considered as Scott's "user costs". The components of these costs are: (1) costs resulting from an incremental fall in resource stock and (2) costs related to the increase in the upper limit in the future if the limit is effective.

Many authors, however, have tackled the subject of exhaustible resource due to the importance of such resources to world industries. They introduced either expansions to Hotelling's theory or departures from it as they considered different aspects. In the next part of this chapter we will confine ourselves to a discussion of the oil depletion problem after making some remarks about the neo-classical theory of exhaustion.

Despite the usefulness of Hotelling's model as an essential reading in this literature, the theory, however, contains some deficiencies. Hotelling

implicitly assumes that spot and bond markets are always in equilibrium and that a complete set of forward markets exists.

It can be shown, however, that these assumptions are unrealistic.In the long term the rate of return on resources is not equal. The same is true of the instantaneous. [6] In addition, in the real world, hypothetical perfect competition does not exist. The assumption of having full knowledge about present and future markets, therefore, loses its validity. Consequently, the optimal rate of depletion will be uneconomical.

It is also argued that exhaustion may not necessarily be desirable. Technology might produce a close substitute for oil, for example, under which oil might be replaced by a cheap energy source.

In addition, the theory of exhaustion had postulated all its conditions with certainty about future demand, future prices and reserves. Uncertainty, however, would affect the analysis if it had been introduced. There is uncertainty about reserves, demand for a certain exhaustible resource and uncertainty about future price. Producers, however, depend only on their expectations for future demand and prices which are questionable.

There are, however, some economists who criticised Hotteling's assumption of constant marginal cost. They

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[6] G. Heal and M. Burrow 'The Influence of Interest Rates on Metal Price Movements' Review of Economic Studies, 47, 1980, pp. 161-181.

assume that this assumption is unrealistic as consumption and production at any point in time depend upon the same activities in all other periods. They introduced average cost of extraction to the analysis. By introducing average cost, they assume that the price of a certain natural resource will be higher than that of a constant one.7

Hotelling's assumption of constant marginal cost maintains its validity in this analysis as total cost is unlikely to be affected by increasing production by one unit. Even if increasing production affects the total cost, this will not be of great significance.

There is no agreement, however, amongst economists as to the optimal rate of resource depletion. Amongst the various issues, the following three points are worthy of attention. The main argument concerns the neo-classical belief that the welfare of future generations is optimally accounted for through the process of present value maximization of future consumer surpluses. Also important, however, is the dispute over the operation of the price mechanism, particularly where there are unusual natural resource markets. Finally, argument rages over whether substitution between resources where one is becoming exhausted can be classed as an issue at all.

Quite apart from these issues, but also a crucial factor, is the danger of attempting to establishing

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7 P. S. Dasgupta and G. M. Heal, Economic Theory and Exhaustible Resources,Cambridge University Press, 1979, Chapter 6.

realistic policy responses based solely on resource issues. Technology may play a part in so far as it decides, over time, what can and cannot be regarded as a natural resource.

As the topic of exhaustible resource depletion has been tackled from many different standpoints, the depletion theory of natural resources remains highly controversial.

With more details in the next section of this chapter, problems related to the theory of natural resources in general and energy depletion (oil) as a special case will be discussed.

4.2 Depletion of Oil

The depletion of energy resources is a very important aspect because some energy resources are non-renewable in a sense that current consumption will deprive our future generations from such useful resources. The question which ought to be posed here is whether the right amount of the energy resources are allocated for the present generation: In theory, it has been assumed that the use of energy resource is optimal according to Pareto optimality. In practice, such optimality does not exist in the real world since governments determine the rate of depletion of energy resources.

Professor Robinson (1975) examined the intertemporal allocation of non-renewable resources and applied it to oil.[8]

Assume that a producer of oil possesses a capital stock of oil (Q) which is capable of being extracted at varying rates over time (q_{t+1} , q_{t+2} , ..., q_{t+n}). The producer is faced by an investment decision. He cannot add to his oil stock, but he can invest in it by keeping it in the ground, whereas extracting it (q) is disinvestment. This is an investment decision as the producer has two choices. He will compare, however, the net present values (NPVS) of all alternative investments assuming that his objective is to maximize the expected net present value of his future investment programme. The producer, therefore, has an expected revenue stream from the sale of future output at future prices. His expected net cash flow will be this revenue stream minus the expected cost stream, with cost being defined for this purpose as including taxes and royalties levied by government. For convenience the net expected price (p) stream is defined as the expected price in any period minus expected cost (c), so that the producer's expected net revenue in year t+1 will be:

$$NR_{t+1} = P_{t+1}\ q_{t+1}$$

$$\text{in year } t+2 = NR_{t+2} = P_{t+2}\ q_{t+2}$$

$$\text{in year } (t+n)\ NR_{t+n} = P_{t+n}\ q_{t+n}$$

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8 C. Robinson, Energy Depletion and The Economics of OPEC, Henley Centre for Forecasting, Occasional Paper No 1, 1975.

His objective function is therefore:

$$\text{Max NPV} = \sum_{t=o}^{n} \frac{(NR)_t}{(1+r)^t}$$

subject to $\Sigma q \leq Q$

$$q \geq o$$

where

Q = Oil stock (given)

r = producer's discount rate

P = Price

q = quantity extracted

(r) is clearly an uncontrollable variable since it depends on the market rate of interest.(q) is a policy instrument so long as the producer has freedom to control his production programme.(P) consists of two components; c, is partly controlled by the producer but is outside his influence due to the imposition of tax unless the producer is a government such as OPEC.(P) will be nearer to a policy instrument the nearer the oil market is to a monopoly.(P) may be considered as a policy instrument in the short term but an uncontrollable variable in the long run.

Assuming that (P) is also exogenous and (q) is the only important variable under the oil producer's control, then the producer's output decision will be a function only of his expectations about interest rate

and prices. So, if the producer has in his mind the price trend in the future, ($\dot{P} = \frac{dp}{dt}$), then he will compare the values of the two exogenous variables; his expected rate of net price appreciation ($\dot{P}$) and his expected interest rate ($\dot{r}$). The only return a producer can get from holding oil in the ground comes from an appreciation in the net price of oil. He must compare the return on this form of investment with the alternative of investing at the market rate of interest.

Thus, production of oil in any time period depends on the expected rate of interest and the expected rate of oil net price appreciation. The higher the rate of interest is relative to the price appreciation rates, the greater oil production will be; the lower the interest rate is relative to the price appreciation, the lower the oil output will be.

If $\dot{P} > \dot{r}$ there is a tendency to hold oil in the ground to take advantage of high expected rates of price appreciation.

If $\dot{P} < \dot{r}$, there is a motive to extract oil now because the price appreciation outlook is relatively poor.

In equilibrium, with $\dot{P} = \dot{r}$, the oil producer is content with his output programme; if he discounts the expected rate of net price appreciation by the market rate of interest which in this case will be his opportunity cost of capital, he obtains a (NPV) of zero on marginal investment. Stock and flow equilibrium are achieved when $\dot{P} = \dot{r}$.

It is argued, however, that oil is substitutable

for another energy resources, therefore, substitution possibilities and demand effect should be considered in order to achieve such equilibrium.

Concerning the substitution effect, W. Nordhaus has drawn attention to such a possibility.[9] He pointed out the fact that technology might produce an alternative for oil at a relatively high cost. Solar or nuclear energy are examples of what are called a "backstop technology". These are assumed to provide us with energy longer than the traditional ones such as oil and natural gas. Oil price increases during the seventies have encouraged the industrial world to look for oil substitution possibilities. Research into alternative energy supplies has been conducted and conservation measures have been taken to reduce the consumption of oil so long as oil prices remained high, from the industrial world's point of view. Although, these measures have led to a reasonable reduction in oil consumption, one could say that the world as yet, has not been able to produce a very close substitute. There will, however, be global dependence on oil as a main source of energy for the next twenty years or so, unless oil prices rise to the extent that nuclear and solar energy are made economically viable. Oil prices, however,are not expected to reach a high level at the end of the Eighties. The use of other energy sources such as coal has been increased in some industrial countries. Consequently, the price went down from $29

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[9] R. M. Solow (1974), op. cit. p.4.

per barrel in March 1983, to $14.25 per barrel in April 1986 as a result of a slacking demand for oil. Under these circumstances, "backstop technology" might put a constraint on oil producers (mainly OPEC members) for failing to negotiate oil prices with consumers.

With respect to the effect of demand on the rate of oil depletion, this effect will be discussed in further detail within the context of the demand function for Saudi Arabian oil.

Due to the great importance of oil on the world energy market, many economists have taken great interest in the theories of oil depletion. These views have varied considerably as the topic has been studied from various angles which are based on various assumptions. Heal, for example, wrote extensively on the subject of oil depletion. In his paper of 1975, he formulated a model regarding the general equilibrium conditions between spot markets and asset markets. [10] He assumes that these markets are always in equilibrium and the adjustment is instantaneous.

Salant (1976) in his paper of "Exhaustible Resources and Industrial Structure" described a World Oil Market which was divided into two groups; the Cartel sector and the Competitive sector. He assumes that countries within the cartel have the oil stock and cost function. In addition, the competitive fringe is assumed to equally share the rest of the oil reserves. The

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10 G. Heal 'Economics Aspect of Natural Resource Depletion' in D.Pearce and J.Rose, Economics of Natural Resource Depletion, The Macmillan Press Ltd.London and Basington 1975.

consumer demand curve and the sales path of the competitive fringe is assumed to be known by the cartel. The problem of the Cartel is to select a price path, given the periphery sales, so as to maximize future discounted profits. On the other hand, the competitive sector's objective is to choose a sales path to maximize discounted profits without exceeding its initial stock, given the centre price. OPEC as a cartel, therefore, will have to take into account non-OPEC oil producers sales when estimation is to be made about future demand and price. This is, however, the case of Nash-Cournot equilibrium where each sector accepts the optimal choice of the other and where neither can, under that assumption, increase its profit by changing its own strategy.

The cartel, however, is a dominant extractor, as it possesses more oil stock than the competitive sector. If it is assumed, therefore, that the competitive fringe completes its sales before OPEC where the termination price is reached, the cartel will take over the market. Before the point of termination price, marginal revenue and oil prices will increase at the rate of interest. When other extractors abandon the market, prices would be lower than interest rates and marginal revenue would be growing at the rate of discount until demand is eliminated.

Despite the usefulness of Salant's assumptions in formulating his model, some are unrealistic. It seems unreasonable, for example, to assume that non-OPEC oil producers have the same oil reserve. They, of course,

have different estimated reserves and if it is easy to get these figures from some countries, it is hard to get the exact amount from the Communist Bloc. Furthermore, his analysis seems to be based on the oil market during the 1970s where OPEC became a power to be reckoned with and oil prices increased sharply. OPEC, nowadays, is unable to influence crude oil prices to the same extent. The spot market, however, plays the principle role. Salant also shares with other theorists the assumption of immediate clearance of both asset and spot market.

Y. A. Stournaras (1985) proposed a dynamic disequilibrium model of an exhaustible resource market. [11] He included the rational expectation equilibrium in his analysis by dividing the economy into present and future periods. Stournaras assumed that all traders use the same expectation rules to forecast price and demand function and the economy is in a temporary equilibrium when spot and asset markets are cleared and the expected oil price complies with the future spot market price. Thus, the expectation is said to be rational if the expected oil price coincides with the spot market equilibrium in the future.

The assumption of rational expectation, however, is a very strong one; expectations might not be rational in a sense that traders will depend on their own expectations to forecast future events. In addition, oil producers may use different methods to estimate oil

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11 Y. A. Stournaras 'A Dynamic Disequilibrium Model of An Exhaustible Resource Market' Oxford Institute for Energy Studies and St Catherine's College, Oxford 1985.

prices. The assumption of producers using the same forecasting rule, therefore, is questionable. He also assumed that the demand function is known for producers. This assumption is hard to be accepted as they depend on their prediction rule to estimate future demand.

In the next chapter, a particular problem is going to be considered; the depletion of oil in Saudi Arabia. The estimation of demand for Saudi Arabian oil will be based on past data by using a discount form of a recursive dynamic linear model. But before that, an analysis will be made of the factors that might affect the rate of oil depletion and the attitudes of OPEC members towards the conservation policy.

4.3 Market Imperfections

The optimum rate of oil depletion and exhaustible resource depletion in general depends on the existence of pure competition, which implies that each producer and consumer have full knowledge of the market. This is, however, the case of Pareto Optimality. With this in mind, the oil market is full of imperfections that violate the optimum conditions of natural resource depletion. These imperfections will now be discussed separately to show in detail the effect of each factor.[12]

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12 For More Details, See P. Dasgupta and G. Heal (1979),op. cit. chapter 11, 12, 13, 14 and 15 ;Also, C. Robinson and J. Morgan, North Sea Oil in the Future, The Macmillan Press Ltd. 1978, chapter 2.

4.3.1 Monopolistic Markets

The oil market is full of imperfections, such as, the existence of monopoly power which is assumed to maximize profits by restricting output and raising the oil price. This, however, would lead to a divergence of the oil depletion from the optimum, as the outcome of the perfect competitive market is not valid. But there are some reasons to doubt the direction of divergence from optimality; these are:-

(a) predictions of the behaviour of firms in perfect competition and monopoly are difficult since costs and demand may be a function of the degree of competition. In addition, the objectives and the rate of technical progress of firms in the two markets may differ.

(b) The monopolistic power cannot ensure the prevailance of the market inelastic demand curve for his product as the price inelasticity of demand is subject to change over time due to an increasing use of oil substitutes. For example OPEC, in the past had exploited the oil market by controlling production which resulted in a high price level of crude oil.If substitutes for OPEC oil, however, are found in the future at a given date and at a given price, the demand for OPEC oil will appear to be less than expected, and price expectations may be revised downwards, which in turn will raise the rate of depletion.

At present the depletion rate of world oil resources is below its competitive level because of the activities of OPEC (which still control production

policy), but output may rise towards or beyond the optimal as the demand for oil became more elastic as a result of recession, conservation, and increasing the use of oil substitutes.[13] The problem is,therefore, to develop substitutes on a sufficiently large scale, thus ensuring that in the long-run OPEC countries will be operating in a competitive market.The world, however, has yet to develop a very close substitute of oil,and increasing the use of other energy sources was only a result of high oil price in the 1970s.

4.3.2 Externalities

An externality in its simplest form means that a decision-maker's activities will be affected by other agents in the economy. It is, however, an indication of market failure. The existence of externalities may lead to a Pareto inefficient allocation of resources as `external' costs or a `diseconomy' exists.[14]

Concerning natural resources, it has been assumed that there is a competitive market for each private commodity in the economy which ensures efficiency.

It is argued, however, that such markets, sometimes, do not exist for different reasons. Externalities occur when the economy is unable to create potential markets for some commodity which makes the Pareto market equilibrium inefficient. Thus, property rights, for

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[13] This point will be discussed in details in ch.5.
[14] C.V. Brown and P.M. Jackson, Public Sector Economics, Martin Robertson, Oxford. 1978, Chapter 2.

example, are an essential condition in establishing the market mechanism. It is difficult, however, to define property rights of some natural resources, such as drilling of oil fields which involve joint ownership.

M. A. Adelman (1972), referred to this problem as a "rule of Capture". [15] He pointed out that oil producers in a certain area may drill the same reserves at the same time. This would lead to an over production and reduce the amount of reserves for future generations. This, however, would increase the rate of oil depletion, as every company is interested in removing oil as quickly as possible. Despite the existence of a unitization of oil fields in certain states of the United States of America, the rule of capture is prevalent.

Pollution, on the other hand, is an externality since the full costs of pollution are still not entering into decision-making. Production, transportation and consumption of fuels, for example, will have an external effect on the environment through emissions to air and water. Fuels, therefore, are on the whole underpriced compared with a system in which prices incorporate social costs. One of the effects of pollution charges would be to raise energy prices compared with prices in general and probably change energy prices relative to one another. Thus, pollution and externalities are raising the depletion rates above the competitive optimum.

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[15] M. A. Adelman (1972) op. cit.P. 44.

4.3.3 Uncertainty and Risks

It has been assumed that individuals made decisions in an environment of complete certainty. This is, however, not a realistic assumption. Uncertainty about the future has a major effect on the rate at which the world depletes exhaustible resources. At the same time, it will encourage the industrial world to look for substitution for fossil fuels such as nuclear energy. With this in mind, the analysis of uncertainty and its effect on natural resource allocation requires the consideration of current production and transmission of information.

Allocation of resources, on the other hand, have been tackled by many economists, among them was L. Walras who pointed out the existence of market equilibrium at any point of time. He assumed the prevailance of perfect competition in which demand meets supply at any time; that the consumer is a utility maximizer and that the producer is a profit maximizer. [16] Under these circumstances, the allocation of resources in a competitive equilibrium is optimal.

Arrow and Debreu in their Theory of Contingent Market showed that a competitive market will not exist in the same way as has previously been described. It

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16 K. J. Arrow and G. Debreu 'Existence of An Equilibrium for a Competitive Economy' Econometrica, 1954, p. 265. Also, see D.M.G. Newbery and J.E. Stiglitz, The theory of commodity price stabilization. Oxford, Clarendon Press 1981, Chapter 13.

requires some conditions to ensure the existence of such equilibrium. The first assumption was that "if every individual initially has some positive quantity of every commodity available for sale, then a competitive equilibrium will exist". [17] The second assumption indicated the existence of a competitive equilibrium if there are some types of labour which are positive and useful. The theory also assumed that there were a finite number of commodities which ought to be bought or sold for delivery at one of a finite number of locations and one of a finite number of future periods of time.

The application of the above theory to the oil market, however, bears some deficiencies. The oil market is characterised by the absence of a future market and there are, therefore, no forward markets for contingent sales.[18] Oil producers, however, depend on their own expectations for future prices by considering past prices, rate of consumption and the remaining stock. Their expectations might lead to a rapid rate of oil depletion if the future price is expected to fall. If the future price is expected to rise, oil producers might hold stock off the market in order to reap the expected benefit resulting from a high price in the future. This might lead to lower future demand and excess future supply and it might encourage the consumer to look for substitutes. A brief look at the trend of past oil prices illustrates that oil prices in 1974 rose

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17 K. J. Arrow and G. Debreu (1954), op. cit. p. 266.
18 P. S. Dasgupta and G. M. Heal (1979), op. cit. pp.440-441.

from a very low level up to four times the previous price. The expectation of OPEC during the 1970s was that demand for oil would rise as long as the world depended heavily on oil as the main source of energy. Consequently, prices increased until they reached $34 per barrel for Arabian light crude oil. There was a change in the oil markets during the early 1980s; a drop in demand, and an increase in the use of alternative energy sources, which reduced oil prices to $29 per barrel in 1983 and to $14.25 in 1986. OPEC, however, is trying to survive the pressure on the oil market by reducing the level of output as their expectations for demand and in turn future supply is pessimistic. Thus, uncertainty about future price will affect the rate of depletion depending upon whether traders expect to increase or decrease current production levels.

In addition to price uncertainty, there is an uncertainty about the size and the quality of reserves. Exploration activities are the only possible method used to estimate the size of an oil reserve through a seismic survey and core drilling, but, one would still be uncertain about the grades of the reserve. Different grades of crude oil require different techniques and might imply different costs. Thus,the size of a reserve determines the rate of production and in turn the rate of depletion.

It has been suggested that conducting a proper research on exploration will be the only way to reduce risk and uncertainty. Such research will provide more information about the uncertain reserves, markets and

prices.

4.3.4 Uninsurable Risks

This risk in the oil market arises from the fact that oil producers are unable to insure against future price deterioration. Their expectations, are somehow not accurate in such a way that future prices might differ from those expected.The rate of oil depletion, therefore, mainly, depends on the traders' expectations over future prices. If an oil producer is risk-averse, he will sell oil now rather than keeping oil in the ground. That is what occured in the oil market in 1960s. The need for financial assets, however, has encouraged oil producers to increase the rate of production to earn more as long as they remained less developed countries irrespective of whether or not they were risk-averse. The situation changed slightly during the Seventies when some OPEC members adopted a conservationist policy to prolong world dependence on oil.

In addition, oil markets are full of political risks. This factor emerged from the increased bargaining position of oil producers in 1973. Apart from that, nationalization and expropriation are other factors of risk that prevail in the oil market.

Thus, it is very hard to decide the optimal rate of resources depletion because of:-

(a) Uncertainties about the environment in which a company operates;

(b) Uncertainties about the companies' aims which may

include objectives other than (NPV) maximization; and

(c) Uncertainty about future prices (the rates of discount which would be appropriate in future years).

One can conclude, therefore, that the presence of uncertainty will lead to a depletion rate differing from the perfectly competitive optimum.

4.3.5 Excessive Interest Rates

The interest rate is an additional factor contributing to the rate of oil depletion. The standard argument is that the interest rate tends to exceed the social rate of time preference, so that oil is consumed excessively and leaves too little to future generations. This argument, however, can be countered by the fact that oil consumption is a procedure which result in investment projects which subsequently provide future generations with the capital necessary for technological improvement.

4.4 Conservation Policy Within OPEC

During the 1950s and 1960s oil production and price policies were determined by multi-national oil companies which were trying to produce crude oil in such a way as to maximized their profits. The principle of oil depletion, therefore, seemed to be ignored at that time. In the beginning, When OPEC gained control of the oil market, they paid less attention to a depletion policy. All of the OPEC members were less developed countries and they are trying to rush the development process forward by using oil revenue to finance their development programmes. The needs of foreign exchange requirements, therefore, encouraged them to increase oil production and enjoy the fruits of their efforts now but at the same time neglecting the needs of future generations. The situation, however, changed during the late 1970s and early 1980s. Some of the OPEC members experienced a balance of payments surplus due to their low absorptive capacity and a high revenue from exporting oil. In addition, prices of capital imported goods went up;the inflation rate rose in the industrial world which affected oil exporters as they depend on the West for their imported technology.[19]

Inflation rates, on the other hand, have a negative

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19 To counter this problem, a suggestion has been made to link oil price with the price index of imported manufactured goods throughout the dialogue between the advanced North and the less developed oil producers; For More Details, See S. Schneider (1983), op.cit. pp.268-281.

impact on the real value of the assets being invested abroad. Devaluation of major currencies such as the Dollar in addition to inflation have reduced the marginal valuation of holding foreign currencies. The establishment of a conservation policy amongst OPEC members, therefore, would seem to be imminent.

OPEC, on the other hand, is an organization which consists of different countries of different economic structures and political regimes. Members of OPEC are divided into two groups; a dominant group with a low absorptive capacity (e.g. Kuwait and Saudi Arabia) and the densely populated group with a high absorptive capacity, such as Iran and Nigeria, which consequently seek a high oil price to finance their internal investment projects. The first group possesses about 56 per cent of total OPEC reserves and they are very keen to keep the oil price at a reasonable level to maintain the demand for oil, as their ability to absorb oil revenue is limited. This limitation is due to their economic infrastructure, the lack of managerial skills and dearth of trained labour. The economic infrastructure of any country, therefore, gives a measure of the internal possibilities for investment. Given the size of their oil revenue and their actual economic infra-structure, these types of countries experienced balance of payments surpluses, some of which have been invested abroad and the rest have been used to diversify the economy outside the oil sector in order to increase their absorptive capacity. The second group are not better off in terms of their economic

infrastructure, but they are capable of investing their revenue internally, given the small size of their oil export (and large potential for development).

With a conservation policy in mind, the above can be considered as an internal constraint to domestic investment opportunities (this subject has been discussed in Chapter Two with respect to the Saudi economy).

A high risk on their external investment is also faced resulting from inflation which prevails in the industrial world and the devaluation of the major currencies. These factors have a major influence on investment opportunities which make the rate of time preference of income lower than the market interest rate. Oil producers, therefore, should withhold production until the market interest rate equals their rate of time preference.

Short and medium external terms are favourable by oil producers as they would like to keep their assets in a liquid form and less risk is involved. Considering the factors that influence oil markets such as reserve uncertainty and demand fluctuation, it is rational for OPEC to link the price of oil with the exhaustion principle.

4.5 Depletion Policy In Theory and Practice

Having discussed the factors that affect the rate of depletion, we now consider whether the world's natural resources are being depleted too rapidly or too

slowly, with special reference to Saudi Arabian case.

The depletion policy is not an easy issue for economists to determine as the oil market is full of imperfections and market failures.

The existence of monopoly, environmental pollution and excessive interest rates are among the factors that influence the rate of oil depletion. With these factors in mind, production regularity seems to be imminent as market imperfections are expected to accelerate the rate of natural resources depletion. It is argued, however, that the market imperfection does not necessarily lead to a rapid rate of depletion. The presence of monopoly, for example, might work towards a conservation policy. During the early 1970's oil depletion was too slow as the result of production control by the governments of OPEC.

The effect of a high interest rate on the oil depletion is also questionable. According to the theory of oil depletion an excessive interest rate would accelerate the depletion rate as oil producers are expected to sell now rather than later. It is argued, however, that a high interest rate would depress investment in general, reducing economic growth and thereby bringing down the rate of oil depletion.

Involved in the issue of depletion policy is the difficulty of how to judge whether the depletion rate is too fast or too slow. This is due to the judgement being based on the economist using the usual standard of comparison for the rate of depletion to be within a perfect market. This concept although helpful, but must

be used with appreciation of its limitations as a perfect market does not exist due to the existence of varying imperfections in the oil market.

Concerning the depletion policy in Saudi Arabia, one should examine the variation of oil depletion during the periods over which property rights have been changed from the hands of the oil companies to the Saudi government.

Since the first oil well was discovered in the kingdom in 1939 and until the early seventies, production and price policies were determined by oil companies. During the 1950s and 1960s, with the interest rate being relatively high, oil reserves in Saudi Arabia have been over-depleted as oil companies had the incentive to increase production and invest elsewhere. In addition, oil companies realized that it was only a matter of time until oil producers took over the oil depletion policy in their territories. Oil resources, therefore, have been over exhausted. When the Saudi government regained control of price and production policies after the first oil crisis, the government, and other OPEC members alike, tended to restrict production and raise prices which in turn resulted in a conservation policy of oil reserves. The situation, however, changed rapidly, for Saudi Arabia; being a less developed country and heavily dependent on oil as a main source for foreign exchange earnings, with market forces which worked their way in favour of oil producers at that time, it soon increased the level of production until it reached around (10) million barrels a day in

1980. This period of rapid exploitation of oil resources in Saudi Arabia can only be judged from an economist's point of view supported by the argument that oil prices in the future should be higher. There are, however, different considerations, that the government might consider when it determines the rate of depletion. Current needs of the economy, might be considered first instead of future welfare. Political factors might also play a critical role in such a way that depletion policy might be determined irrespective of economic theory and the national interest.

Generally speaking the depletion issue is extremely complex, and in some countries especially OPEC members, it is highly confidential. But one could draw attention to the fact that for the Saudi case, the government should adopt a conservation policy in such a way that the kingdom should be the last country to produce the last barrel of crude oil.

CHAPTER FIVE

OIL DEPLETION IN SAUDI ARABIA

The aim of this chapter is to examine the oil market through which a price leadership model can be presented with regards to the economic theory of cartelization. Scrutinizing the market from this basis enables us to evaluate the more familiar argument that OPEC is a cartel. This is necessary as Saudi Arabia is the leader and hence the largest producer amongst OPEC groups and to present a price leadership model for Saudi Arabia, it is important to determine the amount of influence OPEC exerts on the oil market. The need to pursue this study from the cartelization theory is, therefore, important.

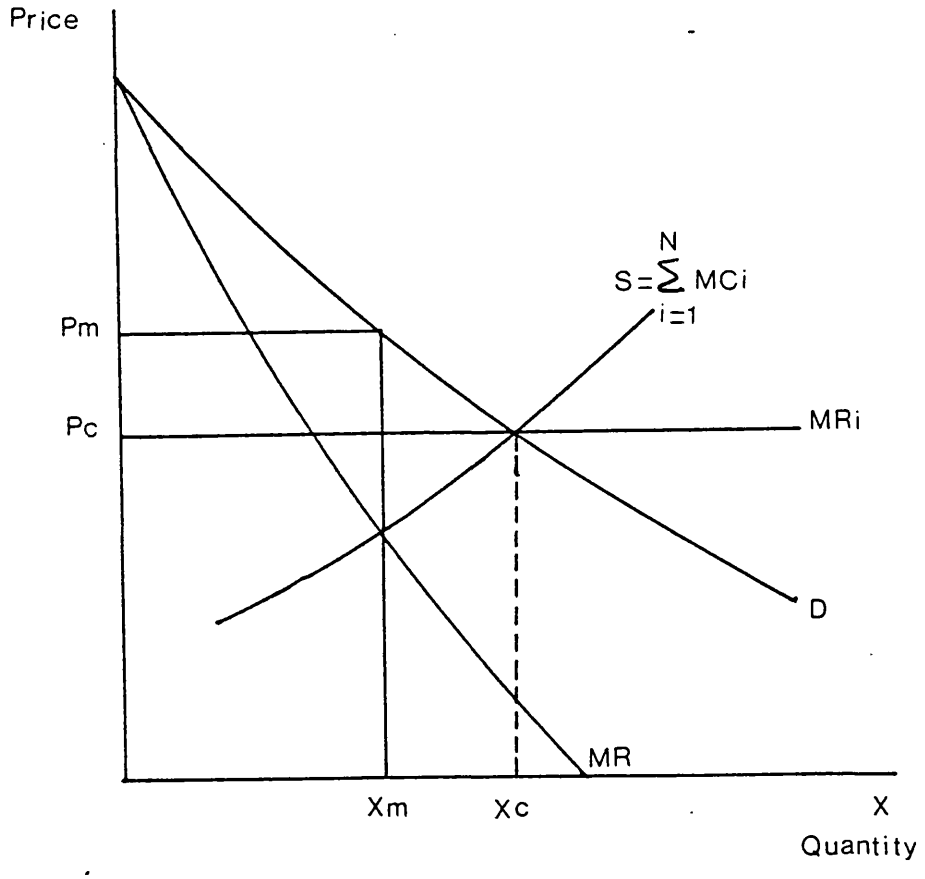
In addition, a demand function for Saudi Arabian crude oil will be formulated in order to estimate the present value of net oil revenue during the planning period and the present value of the remaining reserve after the planning period.

5.1 A Theory of Cartels

The determination of a commodity price in the market is of great interest for economists, in order to analyse the behaviour according to which the price is determined. Setting the price above the marginal cost,

for example, will involve the existence of some monopoly power which accrues to either decreasing cost (natural monopoly) or an agreement amongst producers to act together in collusion.

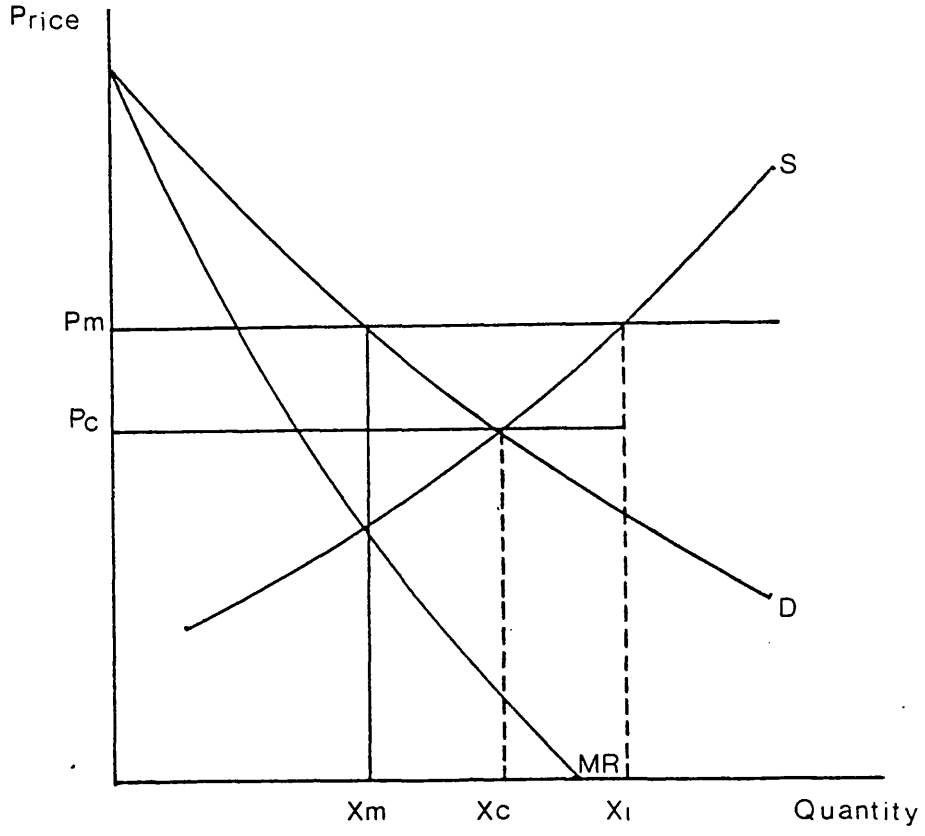
The incentive for competing firms to collude, however, is to maximise the industry's joint profit by avoiding uncertainty arising from their mutual interdependence. The authority of the collusive firms is appointed to a central agency which determines price, quantity and the allocation of output amongst the cartel members. The incentive for firms to collude is shown in Figure (5.1).



THE INCENTIVE FOR FIRMS TO COLLUDE

Given the industry demand curve (D) and the industry supply curve (S), the competitive solution however, is determined by the intersection of the industry demand and supply curves which results in equilibrium price (P_c) and output (X_c). The competitive equilibrium, however, is reached as a result of each individual firm's efforts to maximise its own profit by equating its (MR_i) to (P) and not the industry profit, since the marginal revenue of all firms together is below the market price at any rate of output.

Let us consider the case of collusion where firms are supposed to act together through a joint sale agency. The price and output that maximise the industry's profit are P_m and X_m where MR=MC (as shown in figure 5.2).



THE COLLUSIVE SOLUTION AND THE INCENTIVE TO DEPART FROM IT

In reality, it is not an easy task to achieve as each member has an incentive to violate secretly the agreement in order to gain more profit.[1] Unless the central agency used effective measures to allocate output and profit, each individual firm would be induced to produce more output, say part of X_1 as if they were operating under perfect competition. Collusion, therefore, should be policed and the best way to detect cheating is to obtain the transaction prices from the buyer.

G.S. Becker (1968), however, argues that the gain from collusion is negatively related to the industry's demand curve and positively related to the marginal cost curve.[2] This can be illustrated by using the folllowing formula:

$$G = R-C$$

where G = the net gain from collusion

R = revenue from collusion

C = cost of forming and policing.

G, however, should be greater than zero, and in order to determine G we have to examine the factors that determine R and C. The magnitude of R is determined by the difference between price and marginal revenue :-

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[1] G.J. Stigler, The Organisation of Industry, Richard D. Irwin, Inc. 1968, p. 42.

[2] G.S. Becker, Crime and Punishment: An Economic Approach, Journal of Political Economy, 76, 1968, p. 206.

$$R = P-MR$$

$$R = P-P(1-1/e)$$

$$R = P/e$$

or

$$dR/de<0$$

This implies, however, that the industry's gain from collusion is negatively related to its demand curve.

Concerning the cost of forming and policing the collusion, it should be noted that because there are many factors involved which lead to a non-profit maximization, we would rather confine ourselves to the most common ones which will be discussed in turn.

(a) The number of collusive firms. When the number of firms in the industry is large, it would become very difficult for sellers to agree upon a price structure. Even if we assume that an agreement concerning price has been reached, the probability of cheating amongst members will become very high and hard to detect. This, however, implies an increasing cost of detecting the violation which in turn reduces the gain from collusion. In addition, the greater the number of sellers, the greater the problem of allocating output amongst the collusive firms. On the other hand, the smaller the number of sellers the smaller the probability of cheating as each potential cheater realizes that his action might be punished or that his rival will be induced to act in the same way which, in turn, reduces

the profit of the industry.

(b) Homogeneity of products. One of the conditions for firms to collude is the homogeneity of their products. The complexity of their product structures, however, will lead to a wide differential concerning price agreement. The greater the elasticity of substitution among firms' products, the greater the incentive for collusion. Oil producers, for example, should have the incentive to collude since the elasticity of substitution between the products of any pair of firms is infinite. Product differentiation, therefore, will become impossible and collusion is the best way to increase each firm's profit. Stigler, however, went further by adding the buyer's commitment to the seller's product as a condition for achieving full homogeneity.[3]

(c) Number of buyers. Buyers often play a crucial role in determining the price of any commodity. In the case of collusion, buyers are often interested in shifting their transactions amongst sellers in order to increase their gain from price- cutting. Consequently, each firm is unable to increase its share in the market as buyers are motivated to divulge price reduction in order to have them matched by others. One exception, however, is when the buyer is a government which usually reveals the price and in this case detection of cheating will become almost costless.

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[3] G.J. Stigler, op.cit. p.40.

(d) Loyalty of customers. The detecting of price-cutting will become more costly the more irregular the shift of customers among sellers. In the absence of secret price cutting, buyers will normally stick to one or a few sellers. Each buyer, however, will gain more when the number of sellers exceed the number of buyers.

Having briefly examined the cost of collusion, the gain that could be obtained is, therefore, equal to the difference between revenue (R) and cost (C). Collusion, therefore, will take place if (G) is greater than zero.

The conclusion that can be drawn from the above analysis is that both the competitive and the monopolistic solutions might have economic limitations. A cartel with a central agency might create an administrative problem as a result of detecting price and quantity standards.

G.S. Becker (1971), argues that "for most practical purpose, economists usually have assumed either the fully competitive equilibrium or the fully monopolistic one, even though both may have short comings, because they have lacked a reliable general theory that also covers intermediate positions".[4] The intermediate solution that has been suggested by Professor Becker is when collusion is partially effective.

In addition, the collusive firms might face another problem of how to estimate the rate of production of non-members. Also a problem is the estimation of the industry demand curve which is normally underestimated

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[4] G.S. Becker, Economic Theory, knopf, New York, 1971, p. 100.

because of the unwillingness of the producing firm to reveal its true production figures if extra revenue is largely obtained by producing beyond allocated quotas. Having briefly examined the theory of cartel, the next step is to apply the theory to one of the most arguable issues: OPEC.

5.2 Is OPEC a Cartel?

OPEC has been described as a traditional cartel which controls the supply of and, in turn, price of oil. Those who hold this view probably base their arguments on the assumption that the price of oil should equal its marginal cost. Once the price is above its marginal cost, there exists some monopoly power in the market and the price of oil, therefore, is not competitively determined.[5]

In order to evaluate the above argument as to whether OPEC can be described as a cartel or not, there is an overriding need to look into the historical aspects of the oil market.

During the early seventies, the total cost of oil deliveries to Western Europe was estimated at £5 per ton whereas at that time the average cost of coal produced in Britain was around £7 to £8 per ton.[6] As it takes 1.5 tons of coal to match the energy obtained from one ton

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[5] M.A. Adelman, Is the oil shortage real? Oil companies As OPEC Tax collectors, foreign policy, winter 1972, 73 vol. 8, pp.69-107; Also, Nazli Choucri, International Energy future prices, power and payments, The MIT Press, Cambridge, U.S.A. 1981, p. 3.

[6] The Economist, April 26, 1975, p. 36.

of oil, the equivalent cost of oil, therefore, was £10 to £12 per ton.

Obviously, a substantial rent existed and oil rent, therefore, could be obtained by pricing oil up to just below the price of substitutes such as coal. Oil producers, however, were unable to "cream off" this rent as price and production policy were in the hands of oil companies. The governments of consuming countries got a greater part of this rent in the form of tax from oil companies while the rest was taken by oil companies themselves. The price of refined oil in Western Europe was $14.50 per ton in 1973. Consumer government taxes were around $7.50 whereas the share of producer governments was only $2.32. The remainder of the oil price went to the oil companies as a profit and costs (4.68).[7]

After the first oil price increases in 1973-74, almost everybody, mainly the American writers, called OPEC a cartel. P. Frankel(1973), however, argues that OPEC is "what American authors still call by way of over simplification a cartel".[8]

What really happened ? Did OPEC through its collusive action to restrict output and raise prices cause the problem or had some other factors been involved ?

OPEC was formed in 1960 as a result of the unilateral decision taken by oil companies to reduce oil

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[7] I. bid p. 36.
[8] P.H. Frankel, The oil industry and Professor Adelman, Petroleum Review, 1973, vol. 27, No 321 p. 348.

prices in 1959. The distinctive difference between cartels and OPEC is the nature of membership. OPEC is an association of sovereign states each with its own peculiarities and own objectives. This picture is quite different from the one normally associated with the traditional cartels theory where all members seeking profit maximization act in a well-determined uniform and unanimous way. For example, in the case of perfect collusion, decision making regarding pricing, output, profit sharing amongst cartel members is assigned to the central agency which in the end determines the industry's profit by equating MR to its MC.

When OPEC gained control on prices and output after 1973-74, no quota regulations were immediately imposed on its members to abide by and also there were member states who sold below OPEC prices.[9]

Although OPEC did accelerate the price rise in 1973-74, there were, however, many factors that precipitated this price increase. Industrial technology at that time had been switched from a coal- based technology to an oil- based technology as a result of cheap oil prices during the 1950s and 1960s. Also important was the oil embargo imposed by the Arab countries during their conflict with Isreal in 1973.

Concerning the second oil shock 1979-1980, the instability of the oil market at that time brought about by the Iranian revolution and the outbreak of the Iraq-Iran war, together with the action of Saudi Arabia

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[9] S. El Serafy, Oil and the World Economy - A Different Perspective, finance and Development, March 1982, p. 40.

to reduce its output by around two million barrels a day, caused the second oil price rise in which OPEC normally followed the price in the spot market rather than led it.[10]

Pricing policy after 1973, however, became a major controversy amongst OPEC members. They were divided into two groups; the moderate states such as Kuwait, United Arab Emirates and Saudi Arabia; the leader of OPEC. They tried to stabilize oil prices due to their inability to absorb oil revenue and their desire to maintain the demand for oil. Sheikh Ahmed Zaki Yamani, former oil minister of Saudi Arabia had said "If we force Western countries to invest heavily in finding alternative sources of energy, they will, this would take no more than seven to ten years and would result in reducing the dependence on oil as a source of energy to a point which will jeopardise Saudi Arabia's interest. Saudi Arabia will then be unable to find markets to sell enough oil to meet its financial requirements".[11] The second groups possessed a greater absorptive capacity such as Iran, Nigeria and Venezuela, and as a consequence demanded a higher market price. With these factors in mind, together with the differences among OPEC members in terms of political and economic structures, the task of OPEC to act as a central agency will be either impossible or difficult to achieve. OPEC's functions as an organization is limited to

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10 I. bid. p. 40.

11 This speech being given in the university of Petroleum and Minerals at Dhahran, Febuary, 1983.

collecting technical and economic data while the pricing decision is normally negotiated by oil ministers who represent different views.

In addition, OPEC is not the only oil producer in the world; there are some oil producers outside OPEC such as U.S.A., U.K., Mexico, Norway and the Communist Block whose output increased sharply at the end of the seventies which added another nail to the coffin of oil pricing.

The common perception of OPEC as a cartel is probably based on the following:-

(a) the drastic rise in crude oil prices in 1973-74 and 1979-80.

(b) The OPEC meetings to discuss the oil market, prices and production policy - seen as a classic cartel behaviour.

However, we cannot simply conclude from the above two points that OPEC is a cartel, though, OPEC worked a production quota of 17.5 million barrels a day in March 1983, this quota was difficult to uphold because OPEC members found it increasingly difficult to pursue price stabilization policy while such efforts only permit producers outside OPEC to increase their production. This very fact that outside producers can influence production and subsequently prices of OPEC members nullifies the arguments that OPEC is a cartel.

5.3 Price Leadership Model _ A Dominant Firm Approach

There are many types of price leadership, but we confine ourselves to examining the above- mentioned since it concerns our analysis in this literature.[12]

Consider an industry with N firms that produce a homogeneous product Q. Among the N firms it is assumed that there is a large firm which has a considerable share of the total market and (N-1) smaller firms each of which has a small market share. For simplicity, we assume that each of the (N-1) firms is so small that the effects of its action concerning price and output would not affect the whole industry's output or the decision taken by the large (dominant) firm or by other smaller firms in the group. Practically, it is not always the case that the dominant firm will determine the market price. Some of the small firms might take the initiative and set the market price of the industry. At this stage however, the above assumption will be maintained and we shall ignore its effects until we apply this model to the oil market.

Let (DD) denote the industry demand curve which is assumed to be known to the leader and (S) be the the supply curve of output for the small firms which is also

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12 Many authors have tackled this subject before, such as J. W. Markham in his article: The Nature and Significance of Price Leadership, American Economic Review 41, 1951, pp. 891-905; K.E. Boulding, Economic Analysis, fourth edition, volume one, Microeconomics, Harper and Row, New York, 1966 chapter 22. Amongst those who followed is: A. Koutsoyiannis, Modern Microeconomics, Second Edition, the MacMillan Press Ltd, 1979, pp.244-252.

assumed to be known to the dominant firm by horizontally adding the marginal cost curves of the smaller firms i.e.

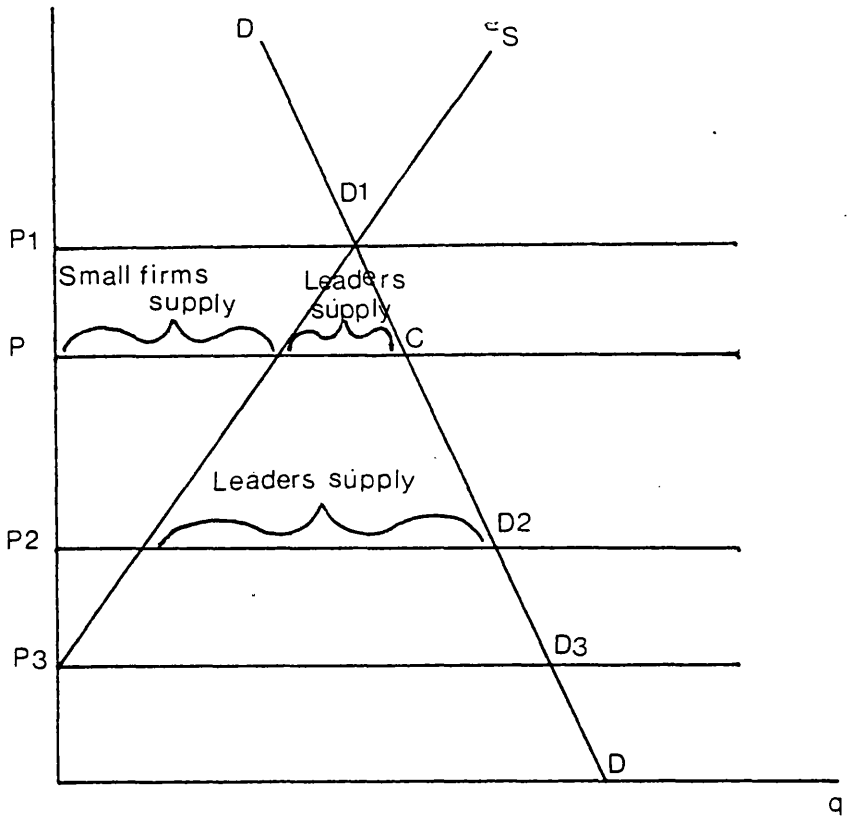
$$S = \Sigma Q_i \mid \Sigma MC_i$$

The leader, however, sets the price so as to maximize its profits, taking output of the small firms as given by (S). That is, at each price the demand for the dominant firm's product will be the difference between the market demand DD and the total supply (S) i.e.

$$dp = DD - S$$

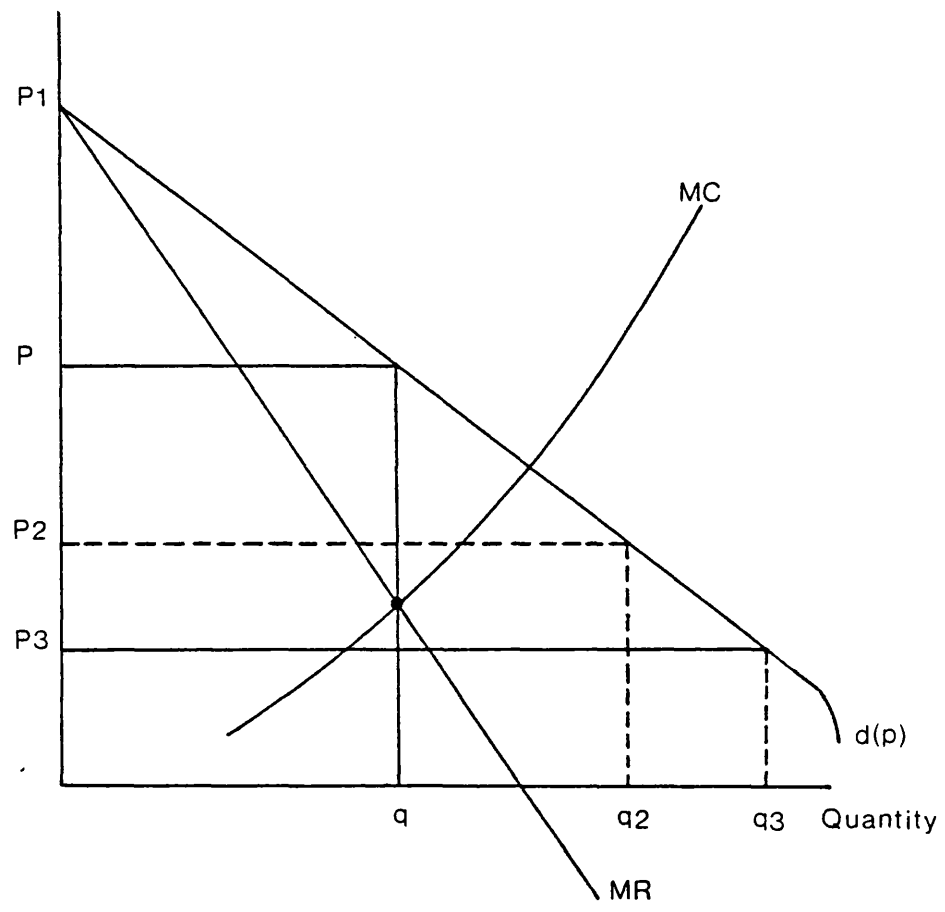
At p_1, for example, the demand for the leader's product is zero as the small firms will supply all of the output demanded. But as prices decrease the share of the dominant firm will be increased. Figure (5.1) and (5.2) indicate the profit maximizing choice by the dominant firms, given its demand dp and marginal cost; the dominant firm will set the price P at which its MR=MC at a rate of output OQ. When the dominant firm sets a price level equal to P the total market demand is PC, part of which PB is supplied by the small firm (N-1) and other parts BC = OQ is supplied by the leader. Thus, the dominant firm maximises its profit by equating its MR with MC. Smaller firms follow, either because it is beneficial or because they prefer to avoid competing against each other, even if this implies a departure from their profit- maximizing goal.

RE (5·3)



INDUSTRY DEMAND CURVE (D D) AND SMALL FIRMS SUPPLY (S)

URE (5·4)



CHOICE OF PRICE AND OUTPUT FOR THE DOMINANT FIRMS

The price leadership model, however, will bring about a stable equilibrium to the market as it is considered an effective means of eliminating price competition among rival sellers in the same industry. This, however, indicates that the dominant firm has to be powerful to make the small firms follow its price fluctuations and abide by the market share. To postulate such an assumption, the dominant firm should be characterized by a large size and lower cost in order to have the ability to manoeuvre on a price basis.

It is argued, however, that the dominant firm does not always set the price on the profit maximization principle since the dominant firm is affected not only by the forces that determine the industry demand curve, but also by the forces that determine the marginal cost curves of the smaller firms in the industry. Any change in the slope or the position of the supply curve will affect the leader's demand curve which in turn changes the profit- maximization goal of the dominant firm.

In addition, the price leadership model does not entail the existence of the dominant firm in every industry that produces a homogenous product. What the model implies is that the dominant firm is aware of its economic power and will exploit it, if it is profitable to do so. In other words, the dominant firm knows for sure the effect of its action on the industry's price product and the rate of output while the smaller firms are assumed to act individually without affecting the market structure of the industry.

Within this price leadership structure Saudi Arabia

acted as a price leader amongst OPEC members. Thus the OPEC pricing strategy depended upon the pricing decisions of Saudi Arabia.

Until the early eighties, OPEC members preferred to follow Saudi Arabian's lead to avoid a price war and to maintain the integrity of their organisation. The prominent position of Saudi Arabia was due to the fact that it possesses the world's largest reserves of oil, estimated at about 168.32 billion barrels of proven recoverable reserves at the end of 1982. [13] In addition, the kingdom was, and still is, the largest producer. Furthermore, the Gulf States who were, and still are, members of OPEC used to back Saudi Arabia since they were also members of the Gulf Co-operative Council of which Saudi Arabia was also the leader.

Saudi Arabia acted as a swing producer which reduced and increased production according to demand fluctuations in order to promote an increasing price level. In 1979, during the Iranian revolution, the kingdom cut its production from 10.4 to 8.0 million barrels per day which forced the price of oil to jump from about $12 per barrel to about $32 per barrel. [14] The Saudi cut in production reduced supply and stimulated demand as every buyer was trying to avoid being in the situation of 1973-1974 crisis when an unanticipated shortage occurred. The kingdom maintained

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13 Ministry of Petroleum and Mineral Resources, Saudi Arabia, Petroleum Statistical Bulletin, 1982, p.16.

14 M.A. Adelman, OPEC As a Cartel in James, M. Griffin and David J. Teece, OPEC Behaviour and World Oil Prices, George Allen and Unwin, London, 1982, pp.37-63.

its role as a price leader during the early Eighties but some remarkable changes occurred in the energy market that forced the Saudi government to take a historical decision. From 1981 and until recently oil consumption has been falling at a rate of 7% compound on average in the industrial world. Higher oil prices relative to alternative energy sources combined with other factors such as conservation policy and substitution of oil for other forms of energy have reduced the demand for OPEC oil. Also of importance is the increasing supply of non-OPEC oil producers. Thus, the falling demand for OPEC oil has put pressure on some OPEC members to offer price discounts in order to increase the volume of oil exports. The kingdom, however, has warned that the oil market will collapse if non-OPEC producers continue their production policy. The situation has deteriorated to the point where the volume of oil export of the leader has been reduced. Consequently, by mid 1985, the kingdom found itself in a position where it was unable to control prices any longer.

Faced with this situation, the Saudi government needed to restore both its prominent position and greater stability in the oil market. As a consequence, they reached a "net-back" agreement with the oil companies. The aim of the agreement was firstly, to increase the volume of oil exports and to ensure revenue essential to the kingdom. Secondly, it was to point out to other exporters that they would be better off co-operating on prices and production rather than competing against each other.

In fact Saudi Arabia's reserve levels and production costs were such that the situation described above could have continued indefinitely without real damage to the kingdom. Saudi Arabia, however, exercised its price leadership role in preventing long- term damage to other producers and in order to stabilise the world market. The net back agreement was a demonstration to other producers that in a broader sense, Saudi Arabia still played the price leadership role.

Having described the nature of the role of Saudi Arabia in pricing oil exports, this gives an indication of its role in deciding its own demand function for oil.

5.4 The Future Demand for Saudi Crude Oil

The demand for the Saudi crude oil depends on the level of income and price of crude oil.[15]

$$D_t = f(Y_t, P_t) \quad (1)$$

The future demand for Saudi crude oil can be estimated by using different techniques. First we try the non-linear regression method according to which the mathematical form of the demand functions can be written as follows:

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15 OECD income has been taken as a proxy (GDP at the exchange rate and price levels of 1980), Man Aggregate, volume one, Paris 1986.

Prices of crude oil have been converted to a real term by deflating by United Nations Index of Unit Values of Manufactured Goods Exported by Developed Countries, Monthly Commodity Price Bulletin 1960-1984.

$$D_t = e^{\alpha, t} P_t^{(b_1 + b_3 D80)} (Y_t / Y_{t-1})^{C1} D_{t-1}^{C2} \quad (2)$$

Taking the log of the above equation will yield

$$\log D_t = a_t + (b_1 + b_3 D80) \log P_t + C_1 d\log Y_t + C_2 \log D_{t-1} \quad (3)$$

Thus the demand for Saudi crude oil has been made as a function of:-

(1) Price

(2) Dummy variable for after 1980 on the price coefficient

(3) Income growth rate

(4) Demand lagged one year

The estimation results show that the demand for Saudi crude oil have been under estimated (as shown in the appendix at the end of this chapter). The reason behind this might well be attributed to the assumption that to the order of sequence of the data sets is unimportant, all data sets having equal value in arriving at the estimates and that the variance of the residual noise component is constant. These assumptions, however, are restrictive for forecasting. Thus, the previous method is less suitable for the purpose of this time series analysis because the relationship between variables might change slowly, rapidly or stochastically over time.

Because of this problem, the alternative method which will be adopted is the discount form of the

dynamic linear model. This method depends on the recursive regression technique and simultaneously gives a one step ahead forecast through the process of regression. The conventional linear regression equation can be extended and written as follows:-

$$Yt = Ft\,\theta_t + E_t \qquad (4)$$

where

F_t is the 1xK vector of independent variables

θ_t is the Kx1 vector regression parameters

E_t is the random error term

Also

$F_t = [P_t, I_t]$ price and income (known)

$\theta_t = [\overset{\alpha}{\beta}]_t$ unknown

The essential difference between this method and the ordinary least square is that the former allows the vector of parameters θ_t and the variances of the residual error to vary over time. θ_t, however, is unknown. Therefore, we need vague information about θ_0 (the initial parameter vector) to start off the analysis, given information available at that time i.e.

$$(\theta_0 | D_0) \approx N[M_0 ; C_0]$$

this is what the Bayesian approach called a posterior

probability distribution

Let $M_o = \begin{bmatrix} 1 \\ 1 \end{bmatrix}$

and

$C_o = Z\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$

Where (Z) is a large number and it is fairly machine sensitive. Though one hundred attempts have been made to reach the proper value of (Z=600).

In general m_t is the estimated mean of θ_t and C_t is its covariance.

Let $\hat{d}_t$ be the estimated demand at time(t) and the past data up to and including the observation d_{t-1}

Johnson and Harrison argue that "if this data produces a vector of parameter least square estimate denoted by m_{t-1}, then the least square estimate for another value of d_t given the vector of the relevant independent variables F_t will be:[16]

$$\hat{d}_t = F_t M_{t-1} \qquad (5)$$

The error between the actual demand and the forecasted demand will be e_t, where

$$e_t = d_t - \hat{d}_t \qquad (6)$$

The value of M_t and C_t ,however, are recursively

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16 F.R. Johnson and P.J. Harrison, Journal of operational Research Society ,1984 ,vol. 35, No. 10, p. 924; Also See P. J. Harrison and C. F. Steven, Bayesian Forecasting, Journal of the Royal Statistical Society, 38, 1976 Series B,pp.205-247.

obtained as follows

$$\hat{d}_t = F_t M_{t-1}$$

$$M_t = M_{t-1} + A_t (d_t - \hat{d}_t) \qquad (7)$$

$$A_t = R_t F_t^T / \hat{Y}_t \qquad (8)$$

$$R_t = C_{t-1} / B \qquad (9)$$

$$\hat{Y}_t = F_t R_t F_t^T + V_t \qquad (10)$$

$$C_t = R_t - R_t F_t F_t^T R_t / \hat{Y}_t \qquad (11)$$

Therefore

$$M_1 = M_0 + A_1 (d_1 - \hat{d}_1)$$

$$A_1 = R_1 F_1^T / \hat{Y}$$

$$R_1 = C_0 / B$$

$$\hat{Y}_1 = F_1^T R_1 F_1 + V_t$$

where

$\hat{d}_1$ and $\hat{Y}_1$ are the expected mean and the variance of d_1 (conditional on f_1) given data up to and including d_0, f_0 (i.e. one step ahead forecast) so that the quantity (e) is the conditional one step ahead forecast error. Proceeding in this analysis for K steps ahead, the forecast function is:-

$$\hat{d}_{t+K} = F_{t+K} M_{t;K} = F_{t+K} C_t F_{t+k}^T + S_t^2 \qquad (12)$$

where

$M_{t,K}=E(\theta_{t+K}|$ the information up to and including time $t_{-1})$

It is important however to notice that this method depends also on discount factors which determine the rate of decline of information from the observation made. Without considering the fluctuation of information (i.e. all points being given equal weights), the method is exactly equivalent to the ordinary least square estimate. B, therefore, is a discount factor if and only if $0 \leqslant B \leqslant 1$.

Considering the estimation of residual variance, it should be noted that the error (e) can be divided into two parts, one associated with error in the parameters estimates and that associated with the residual variance V_t.

Then

$$V_t^2=e_t^2(1-F_t\ A_t) \quad (13)$$

Let S_t be the sums of squares of the residual errors.

$$\text{Then } S_t=BS_{t-1}+V_t^2 \quad (14)$$

where the initial value of (S_t) is zero and one for (V_t).

5.4.1 Estimation Results

$$\log D_t=\alpha+b_0\log Y_t+b_1\log P_t$$

$$\log D_t=-4.818 + 2.143\log Y_t-0.097\log P_t$$

$$(-1.998)^{*} \quad (3.081)^{**} \quad (-0.405)$$

R =0.871

discount factor = 0.97

values in parentheses are T- statistics

* Significant at 10%

** Significant at 1%

Concerning the value of The intercept, at 5% level of significance, -4.8 lies within $\pm$ 2.069 standard error; i.e. within $\pm$ 4.98829693 (the critical value x the estimated standard error). Therefore, -4.8 is not significantly different from zero.

T-statistics in both models (non-linear regression and the discount form of dynamic recursive linear model) show that the price of crude oil is insignificant, (-0.472) and (-0.405) respectively. This might seem a strange phenomenon to the reader as oil prices cover almost the whole literature of oil studies. Viewing the economic theory, however, might provide us with an explanation to the above results.It is well known that the price of any commodity is determined by the mechanism of supply and demand. The demand for oil, however, was inelastic during the seventies and up to the second oil crisis in 1980.The nature of the elasticity of demand emerges from the fact that oil was the main energy source, for which very close substitutes were not available. Even where those did exist, they were relatively more expensive. Apart from that, the demand for crude oil is derived from the demand for final products which had also been increasing. Due to the special characteristics of oil products, increases

in oil prices are normally accommodated by making savings in other sectors hence the significance of price in demand for oil may be low, the demand for oil was price inelastic.

Also important was the speed of market adjustment to oil price increases which was rather slow. [17] Although consumption of energy slowed down after the first oil crisis 1973-74, it was rising for all fuel and up to the second oil crisis 1979-80 oil consumption, in particular was still higher in 1980, 3001 MT than that of 1973, 2795.[18]

The elasticities of demand, however, were very low in both models, (-0.04) and (-0.08) respectively. The reason behind this could well be due to the fact that we used historical data over which the demand was inelastic especially during the Seventies.

The main purpose of this analysis is to estimate the demand for Saudi Crude oil during the planning period (1986-1995) in order to estimate the goal function of the kingdom (i.e. the total wealth of oil reserves in Saudi Arabia.

Demand when price	$10	$18	$24
(billion barrels) with z=600)	3890.00	3698.00	3605.00

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17 The Market Adjustment of Oil Price increase will be discussed in detail in Chapter 6.

18 BP statistical Review of World Energy 1984.

4275.00	4073.00	3971.00
4623.00	4395.00	4285.00
4909.00	4666.00	4560.00
5140.00	4886.00	4764.00
5333.00	5069.00	4943.00
5482.00	5211.00	5093.00
5610.00	5333.00	5211.00
5714.00	5432.00	5308.00
5807.00	5520.00	5382.00

The planning period, however is ten years; from 1986-1995. Although it is very difficult to predict what will happen in any future market commodity, especially those badly needed for industrial uses such as oil, the planning period is based on some assumptions regarding the price of crude oil and the income of OECD.

In December 1985 the price of crude oil went down to $26 per barrel and to $14.25 pb in the following April as a result of a falling demand for oil. The combination of recession, the conservation measures taken by consumer countries and increasing oil substitutes had reduced the dependence on oil as a main

source for energy. Due to this uncertainty both at the present time and in the future, different assumptions have been made about future prices of crude during the planning period and afterwards. The prices of oil after the planning period are assumed to be higher than those of the planning period, as the price of any exhaustible resource goes up when the quantity demanded approaches zero.

Concerning the supply side of crude oil, it has been assumed throughout the analysis that demand will create its own supply in the market. OPEC members are LDCS and mainly dependent upon oil exports for their revenue necessary for their development. Accordingly one would expect them to supply oil until the reserves are exhausted. Therefore, projections of future supply have been ignored.

Concerning the income of OECD countries, the following formula will be used to estimate that income during the planning period;

$$\hat{Y}_t = \alpha(Y_{t-1}) + (1-\alpha)\hat{Y}_{t-1} \qquad (15)$$

where

$\hat{Y}_t$ = is the year to be estimated

$\hat{Y}_{t-1}$ = the difference between the last two years

i.e. $(Y_{t-1})-(Y_{t-2})$ plus the value of Y_{t-1}

The value of α is between 0.1 and 0.2. The estimated income and demand during the planning period will be presented in the Appendix at the end of this

chapter.

5.5 The Saudi Arabian Goal Function

The goal function of the Saudi Government is the maximisation of the total wealth of its oil reserves. It can be estimated by following H. Ben-Shahar's Approach.[19] This function,however, can be divided into two components, the present value of net oil revenues during the planning period, and the present value of the oil reserves remaining after the planning period.

5.5.1 Present Value of Net Oil Revenue

The present value of net oil revenues from the sale of oil during the planning period is given by the following formula;

$$Pv_1 = \sum_{t=1}^{T} \frac{1}{(1+r)^t} (P_t - C_t) D_t \qquad (16)$$

where

Pv_1 = Present value of net oil revenues.

P_t = Crude Oil price at year t.

C_t = Marginal Cost of oil production at year t.

D_t = Demand for Saudi Crude oil.

r= Interest rate

T= Last year of the planning period.

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19 H. Ben-shahar, Oil Prices and Capital, Lexington Books, 1976.

5.5.2 Present Value of Remaining Oil Reserves

The remaining reserves of Saudi Arabia by the end of 1982 were 168.32 billion barrels. Allowing for the discovery of new reserves in Saudi Arabia and taking the reserves to production ratio, the reserves are assumed to be depleted gradually over a period of 80 years. Thus the reserves will be sold off by the year 2075, the mean year being 2035. For simplicity, the present value of the Saudi reserves can be roughly estimated by the following formula

$$Pv_2 = \frac{1}{(1+r)^{T+40}} (P^1 - C^1)(R - \sum_{t=1}^{T} D_t) \qquad (17)$$

where

Pv_2 = Present value of remaining oil reserves.

P^1 = Price of crude oil after the planning period

C^1 = Marginal cost of oil production after the planning period

R= Total present reserves

ΣD_t =Total demand of oil during the planning period.

T+40= Mean year

This equation, however, can be divided into two components

$$Pv_2 = \frac{1}{(1+r)^{T+40}} (P^1 - C^1)R - \frac{1}{(1+r)^{T+40}} (P^1 - C^1)\sum_{t=1}^{T} D_t \qquad (18)$$

The first component measures the present value of the

remaining reserve if no sales occurred during the planning period. This, however, is independent of the price pattern during the planning period, and it can be deleted without affecting the optimal solution.

The second component represents the opportunity cost of selling oil during the planning period as in order to obtain revenue from the sale of oil the producer reconsiders the opportunity to sell this oil after the planning period.

Thus the goal function can be simplified by deleting the first component of equation(18) and the remaining equation represents the net gain from the sale of oil during the planning period. The gain is net because it measures the present value of net revenues from oil sold minus the present value of this oil if it had remained in the ground. Thus, the net gain function is:

$$vn=\sum_{t=1}^{T}\frac{1}{(1+r)^t}(P_t-C_t)D_t \quad - \quad \frac{1}{(1+r)^{T+40}}(P^1-C^1)D_t \qquad (19)$$

and the Saudi goal function is:

$$vn=\max\sum_{t=1}^{T}\frac{1}{(1+r)t}(P_t-C_t)D_t \quad - \quad \frac{1}{(1+r)^{T+40}}(P^1-C^1)D_t \qquad (20)$$

subject to

$$\Sigma D_t \leq R$$

R=Reserve

The results are shown in the Appendix at the end of this chapter. The empirical work shows that any variation in the crude oil price will affect the

quantity demanded during the planning period.

The future price of crude oil, however, is normally determined by the mechanism of supply and demand for oil. Concerning the supply side, there exists a large excess producing capacity, most of which comes from non-OPEC oil producers. Future prices, therefore, will partly depend on how this excess in supply can be controlled. It is highly unlikely that oil producers as a whole would reach a unanimous agreement on the supply side, especially when one considers the political factor that might be involved in this issue.

Even when it was evident to Britain that cooperating with OPEC is in its best interest, because of the Conservative Government's commitment to non-intervention in markets, the regulation of North Sea oil production was prevented.

Also, a country like Nigeria with its inherent political and economic problems could not cut back supply preferred to enter into various counter-trade deals with Brazil in particular and oil companies to barter crude oil for essential commodities. This deal was not included in the official production quota allocated to her by OPEC.

Iran is another example. Because of its war with Iraq, Iran has been known to have sold oil below $9 a barrel at a time when a barrel officially sold for $32. This was an effort to secure ammunitions and supplies for the war effort.

Because of the above factors and many others, it seems that the achievement of a unanimous agreement to

maintain supply will continue to elude OPEC.

Concerning demand, it is argued, however, that the combination of recession and conservation measures adopted by consumer countries are the main factors which caused the fall in demand for oil. If it is a recession which caused the fall in demands, then one would argue that if the world's recession comes to an end, i.e. if there is recovery, the demand for oil will increase. If, however, it is conservation, which is the most important factor, then clearly as the world comes out of recession, the demand may fall even further. This, however, depends on the mechanism of appliance stock turnover. Thus, we have to ponder upon new, more energy efficient appliances coming on to the market and on the way which this turnover of the appliance takes place. 20 It is useful, however to distinguish between capital goods such as boilers, electricity generators ie energy using capital stock, and consumer durables such as cars. During the recession, capital goods are assumed to stand idle and might be scrapped, presumably the older and less efficient would be scrapped first. When the world is moving to an economic boom situation, one would expect an increase in investment for new capital equipment which is going to be of a more efficient variety. So it is quite conceivable to argue that as far as capital goods are concerned, when the boom comes, initially we may see some increase in energy demand, but

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20 Graham, M.G. Factors Affecting the Future Pattern of the World Energy Market, in the Sixth World Power Conference Proceedings, Melbourne, October 1962.

as new investment and the capital appliance stock turnover take place, the demand is going to flatten out again as it did before.

Concerning consumer durables, the situation however, is different. During the economic recession, we would argue that consumers are expected to prolong the life of their consumer durables. They might wait another year, for example, to buy new cars. When we move to a boom situation with rising income, the majority of the people are expected to buy new, efficient, energy consuming cars which accelerates the appliance stock turnover. Consequently, the demand for crude oil will be less due to the increase in the appliance stock turnover. Therefore, the demand for crude oil from industrial countries is expected to be fairly flat over the next ten or fifteen years.

Changing demand, on the other hand, will have its effect on total revenue from the sale of oil during the planning period and the amount of reserves remaining after the planning period. The demand for Saudi Crude oil during the planning period and after, however, will depend on the forces that determine the international demand for oil. Although Saudi Arabia is unable to control these forces, it can alleviate the pressure on the oil market by setting the price of the market crude at a reasonable level to maintain the demand for oil. Being first in reserve and production, the kingdom will control the oil market if we ignore what technology might produce in the future.

APPENDIX A

1. Non-Linear Regression Estimates

$$D_t = a1t + (b + b3D80)\log p_t + C1 d\log Y_t + C2 \log D_{t-1}$$

$$D_t = 0.005t + (-.045 - .070D80)P_t + 3.7 d\log Yt + .000 D_{t-1}$$

(0.68) (-0.47, -2.50) (1.90) (28.56)

$R^2 = 0.978$ $\bar{R}^2 = 0.973$ Dw=1.87

where

$a_1 = 0.005$ (or0.5%) average annual growth rate of demand

$b_1 = -.045$ price elasticity

$b_3 = -.070$ The effect of dummy variable on price elasticity

$C_1 = 3.7$ Income growth rate elasticity

$C_2 = 0.999$ Price elasticity of demand lagged one year.

2. Estimated Demand for Saudi Crude Oil by Using the Above Technique (Billion Barrels)

YEARS	PRICE $10	PRICE $18	PRICE $24
1986	1598	1493	1445
1987	1684	1471	1376
1988	1726	1408	1275
1989	1730	1319	1155
1990	1697	1209	1024
1991	1646	1096	899
1992	1586	987	783
1993	1520	885	679
1994	1454	791	587
1995	1389	706	507

APPENDIX B

Estimated Saudi Arabian Net Gain (Billion Dollars)

At a rate of interest =8%

Oil price during the planning period =$10 (per barrel)

Oil price after the planning period =$30 (per barrel)

Year	Present Value of Net Oil Revenue	Opportunity Cost	Net Gain
1986	34218	4891	29327
1987	34819	4977	29842
1988	34864	4983	29881
1989	34278	4900	29379
1990	33233	4750	28483
1991	31927	4564	27363
1992	30388	4344	26044
1993	28794	4116	24678
1994	27155	3881	23274
1995	25553	3652	21901

A.4

Estimated Saudi Arabian Net Gain (Billion Dollars)

At a rate of interest = 8%

Oil Price during the planning period = $18 (per barrel)

Oil price after the planning period = $35 (per barrel)

Year	Present Value of Net Oil Revenue	Opportunity Cost	Net Gain
1986	63032	5720	57312
1987	64140	5820	58320
1988	64223	5828	58395
1989	63145	5730	57415
1990	61216	5555	55663
1991	58812	5337	53475
1992	55977	5080	50899
1993	53041	4813	48228
1994	50022	4539	45483
1995	47071	4272	42799

Estimated Saudi Arabian Net Gain (Billion Dollars)

At a rate of interest = 8%

Oil price during the planning period = $24 (per barrel)

Oil price after the planning period = $40 (per barrel)

Year	Present Value of Net Oil Revenue	Opportunity Cost	Net Gain
1986	84644	6549	78095
1987	86130	6664	79466
1988	86242	6673	79569
1989	84794	6561	78233
1990	82208	6360	75848
1991	78976	6110	72866
1992	75169	5816	69353
1993	71226	5511	65715
1994	67173	5197	61976
1995	63209	4841	58318

Estimated Saudi Arabian Net Gain (Billion Dollars)

At a rate of interest = 10%

Oil price during the planning period = $10 (per barrel)

Oil price after the planning period = $30 (per barrel)

Year	Present Value of Net Oil Revenue	Opportunity Cost	Net Gain
1986	33595	2305	31290
1987	33564	2303	31261
1988	32997	2264	30733
1989	31853	2185	29668
1990	30320	2080	28240
1991	28598	1962	26636
1992	26725	1834	24891
1993	24863	1706	23157
1994	23021	1579	21441
1995	21269	1459	19810

Estimated Saudi Arabian Net Gain (Billion Dollars)

At a rate of interest = 10%

Oil price during the planning period = $18 (per barrel)

Oil price after the planning period = $35 (per barrel)

Year	Present Value of Net Oil revenue	Opportunity Cost	Net Gain
1986	61886	2696	59190
1987	61829	2693	59136
1988	60783	2648	58135
1989	58675	2555	56120
1990	55852	2433	53419
1991	52681	2295	50386
1992	49230	2144	47086
1993	45799	1995	43804
1994	42408	1847	40561
1995	39180	1707	37473

ESTIMATED SAUDI ARABIAN NET GAIN (BILLION DOLLARS)

at a rate of interest = 10%

Oil price during the planning period = $24 (per barrel)

Oil price after the planning period = $40 (per barrel)

Year	Present Value of Net Oil Revenue	Opportunity Cost	Net Gain
1986	83105	3086	80019
1987	83027	3083	79944
1988	81623	3031	78592
1989	78793	2926	75867
1990	75001	2785	72216
1991	70743	2627	68116
1992	66109	2455	63654
1993	61502	2284	59218
1994	56947	2115	54832
1995	52613	1954	50659

Estimated Saudi Arabian Net gain (Billion Dollars)

At a rate of interest = 12%

Oil price during the planning period = $10 (per barrel)

Oil price after the planning period = $30 (per barrel)

Year	Present Value of Net Oil Revenue	Opportunity Cost	Net Gain
1986	32995	1101	31894
1987	32376	1080	31296
1988	31260	1043	30217
1989	29638	989	28649
1990	27707	925	26782
1991	25669	857	24811
1992	23558	786	22772
1993	21525	718	20807
1994	19575	653	18922
1995	17762	593	17169

Estimated Saudi Arabian Net Gain (Billion Dollars)

At a rate of interest = 12%

Oil price during the planning period = $18 (per barrel)

Oil price after the planning period = $35 (per barrel)

Year	Present Value of Net Oil Revenue	Opportunity Cost	Net Gain
1986	60781	1288	59493
1987	59640	1264	58376
1988	57585	1220	56365
1989	54596	1157	53439
1990	51040	1081	49959
1991	47283	1002	46281
1992	43396	919	42477
1993	39651	840	38811
1994	36059	764	35295
1995	32720	693	32027

Estimated Saudi Arabian Net Gain (Billion Dollars)

At a rate of interest 12%

Oil Price during the planning period = $24 (per barrel)

Oil price after the planning period = $40 (per barrel)

Year	Present Value of Net Oil Revenue	Opportunity Cost	Net Gain
1986	81621	1474	80146
1987	80088	1447	78641
1988	77328	1397	75931
1989	73314	1324	71990
1990	68539	1238	67301
1991	63494	1147	62347
1992	58275	1053	57222
1993	53246	962	52284
1994	48422	875	47547
1995	43937	793	43144

CHAPTER SIX

STRUCTURAL CHANGES IN THE ENERGY MARKET

The aim of this chapter is to examine the major changes which have occurred in the energy market from 1950 until recently and to explain the factors that have contributed to those changes.

The energy market witnessed two major oil price increases; in 1973-74 and 1979-1980 and three price decreases: in 1983, 1985 and early 1986. It is useful, therefore, to start this analysis by examining the energy market trends in the pre- and post-crisis periods (until the end of 1980) in order to understand the nature of those changes.

6.1 Market Structure Pre-1973 and post 1973

The pre-1973 period was characterised by three important features:

a) A rapid growth in world energy consumption at around 5 per cent per annum compound on average. In addition, the World real GNP had been growing at a similar rate, i.e. there was a close relationship between economic growth and world energy consumption. [1]

Table 6.1 shows that the growth of consumption was

faster in the developing and centrally planned economies than in the developed world. The reason for this could be well attributed to the decline in the relative importance of agriculture and to industrialisation.

b) A drastic decline in the share of solid fuel in world energy consumption. Table 6.2 shows that between 1950 and 1973, the share of coal fell from 61 per cent to 30 per cent, despite the fact that coal consumption in this period had been rising steadily at 1.6 per cent per annum on average. The reason for this was due to the fact that solid fuel consumption had been growing at a slower rate than total energy consumption, therefore, the consumption of coal actually declined.

c) A sharp rise in the consumption of oil and natural gas during this period. The combined market share of these fuels increased from 37 per cent in 1950 to 67 per cent in 1973 and clearly this caused a decline in coal consumption. The rapidly increasing consumption of oil and natural gas was accomplished by a rapid increase in world oil production between 1960 and 1973, most of which came from the Middle East area (see Table 6.4). Cheap oil prices encouraged the world to switch to oil-based industries. The trend of oil prices had been downwards for the whole period of 1957-1970. In 1957, however, posted prices were increased all over the world in response to a United States increase. Higher posted prices meant higher payments to host governments and since wide discounts were taking place, the 1957

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[1] IEA, World Energy Outlook, OECD,Paris, 1982, p.63.

increase soon appeared to be a mistake, and in 1959 posted prices were reduced. [2] The decision to reduce prices was taken unilaterally by the international oil companies which provoked the formation of OPEC in September 1960. Since then posted prices have merely been a way of calculating taxes and royalties to governments. Falling oil prices stimulated rapid economic growth in the 1960s and early 1970s caused by a remarkable expansion of the world oil industry, with rising oil output and a low cost of developing, producing, transporting and refining crude oil. It was also the result of rising competition between oil companies in the 1960s.

Oil consumption, therefore, increased at the expense of coal, mainly because its price was falling relative to the price of coal. A low oil price level stimulated the improvement of technology which brought oil into widespread use, so much so that eventually most industrial countries became dependent on imported oil for most of their energy requirements. At the same time the transport of natural gas in liquid form by pipeline began to spread internationally and in 1973 world gas consumption was over six times its 1950 level as shown by Table 6.2.

During the late Sixties and in 1970 there was a widespread belief that the real price of crude oil would continue to fall over time as it had in the past, since oil output was expected to continue rising. [3] These

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2 Morris A. Adelman (1972), op. cit p.161; Also, S. A. Schneider (1983), op. cit. p.83.

expectations, however, were not fulfilled since in the Autumn of 1973 oil prices increased sharply bringing about a world recession. These two features represented a remarkable change in oil market trends.

The 1973 oil crisis was brought about by changing market conditions in favour of oil producers and a Middle East output restriction. The real turning point in the oil industry, however, came around 1970 coinciding with the first North Sea oil discoveries. [4] During the late Sixties and until 1970, demand for oil products increased more rapidly than expected in Western Europe. Most of the profits, however, went to the integrated oil companies. In addition, the governments of oil producing countries in North Africa demanded higher tax payment. This demand was met in May 1970 when the Trans-Arab pipeline was blocked by Syria, and the Libyan Government began production cutbacks for the companies operating there. The effects of these cutbacks, however, were very small as relatively little crude oil was involved. The Libyan action, however, was helped by the Tapline closure which put pressure on oil companies to agree to a tax increase. Other oil producers in the Arabian Gulf demanded and received the same increases.[5]

Thus, the Libyan restriction on output expressed the bargaining strength of the oil exporting countries which through their combined membership of OPEC

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[3] S. A. Schneider, op. cit. p.101; Also, C. Robinson and J. Morgan (1978) op. cit. p.3.
[4] C. Robinson and J. Morgan (1978) op. cit. p.4.
[5] Morris Adelman (1972) op.cit. p.251.

controlled over 86 per cent of world oil exports in 1972, a year before the crisis. This brief survey of crude oil prices from 1970 to 1973 gives the impression that these prices rose steadily until October 1973 when oil prices exploded (as shown in Table 6.6).In 1974 oil prices increased by almost eight times the nominal prices of 1970 and by three times in real terms. During the period 1974-1979 real crude oil prices were almost stable until the second increase took place, 1979-1980, which led to the export price of light Arabian crude oil - the "Marker Crude" - being $32 at the beginning of 1981 compared to the nominal price of $1.80 per barrel in 1970. The real price, however, was less than that due to the prevalence of inflation in the industrial world. Deflating by the United Nations Dollar Index of Unit Values of World Export of Manufacture goods, the real price increase was five times higher than the 1970 price. If the whole period 1950-1980 is considered, oil price increases were less at around 10 per cent per annum in nominal terms and 5.7 per cent per annum in real terms compound on average. Thus, the oil price increases were dramatic and led to changes in the structure of the world energy market after 1970.

Contemplating the energy market; with oil and natural gas being of greater importance than other fuels; economists would predict that there would be a desire amongst consumer countries to reduce their dependence upon oil and gas. Their ability to do so would increase too, as technology changes would be stimulated. It is desirable, therefore, to examine the

energy market changes in order to see if any forces were set in motion to bring such adjustments about.

The first change to be witnessed was in the average growth rate of total world energy consumption. Between 1973-1980, the rate of growth was 2.2 per cent per annum compared to 1965-73 when it was 5.2 per cent per annum (Table 6.3). This is indeed what one would have predicted (i.e. that with rising energy prices, for any given growth of GNP, there will be a much slower rate of growth of energy consumption than if prices were falling). Economic growth rates after 1973 declined and world recession was set in motion. It is not fair, however, to attribute the world recession wholly to the oil crises. What is clear is the existence of a relationship between these two phenomenona.The slower GNP growth was partly a consequence of lower energy consumption, caused by higher energy prices, while at the same time lower GNP growth contributed to lower energy consumption. The combination of the oil crises and the world recession was the factor leading to the remarkable changes in the trend of the energy market.

The second change concerns the consumption of different fuels. Table 6.3 shows that oil consumption declined from a growth rate, 7.8 per cent per annum between 1965-73, to around only one per cent per annum between 1973-80. Natural gas consumption fared no better than oil. The rate of growth of natural gas consumption fell from 6.4 per cent per annum between 1965-1973 to 2.8 per cent per annum between 1973-80. Coal, however, was the only fuel which showed an increase in the rate

of consumption, which grew by 2.6 per cent per annum between 1973-80, compared to only 1.6 per cent 1965-73.

The price increase, however, seem to have taken some time before bringing about any effects and such effects became clearer as time passed. The evidence of this is found in Table 6.3. Table 6.3 shows that the growth rates of energy consumption in the post 1973 period were lower than in the pre-1973 period, but also that there are differences in trends between 1973-79 and 1979-80 periods. After the first crisis and up to 1979 the consumption of energy slowed down but was rising for all fuels, whereas after the second crisis total energy consumption was actually falling and so was oil consumption. Table 6.3 shows this more clearly: between 1979-80 total world energy consumption actually fell from 6,939 to 6,896 metric tons of oil equivalent, whereas the same table shows that oil consumption in 1979 was higher than in 1973 ; 3,124 M.T. compared to 2,798 M.T. in 1973, while in 1980 it fell to 3,001 M.T.

For the industrial world, since in 1973-79 energy consumption was rising and in 1979-80 it was falling, the net increase between 1973-80 was almost zero, (0.4 per cent per annum), as Table 6.9 indicates. In fact, the increase was concentrated in Australasia, the Eastern Bloc and the developing countries, where development continued. With respect to the Eastern Bloc, it is the USSR that supplies oil to the rest of the countries at a price approaching but lagging behind the rest of the world oil prices, so that consumption continued to rise. Table 6.10 shows that oil consumption

rose faster in the USSR, E. Europe, China and the LDCS, while in some places it fell, or increased very slowly (as in Australia). As a consequence, the share of the Eastern Bloc and LDCS consumption increased between 1973-80 from 38 per cent in 1973 to 44.9 per cent in 1980. The share for all other regions declined, the most marked being in Western Europe.

Furthermore, there has been a reduction in OPEC's share of world oil output. As Table 6.8 indicates, its share has fallen from 55.9 per cent in 1973 to around 45 per cent of world output in 1980. As Table 6.8 shows, OPEC output has followed a roughly downward trend between 1973-80, while at the same time non-OPEC output has been rising annually since 1973. One should not forget, however, that part of this rise was due to a continual increase in production since 1973, in the Eastern Bloc, while output in many other countries fell as noted earlier. Due to the Iranian revolution in 1979 and the out - break of the Gulf War in September 1980, production was further reduced and the downward trend in OPEC's share seemed well established. This could be partly attributed to a deliberate policy of conservation adopted by consumer countries. This trend was also partly due to increased competition from newer non-OPEC producing countries such as Britain and Norway. These have increased their production and Soviet output has also risen. OPEC's share of world oil exports has also fallen from its peak of over 86 per cent in 1972 to just over 80 per cent in 1979.

Clearly, the oil price increases of 1973-74 and

1979-80 have brought about many changes though not as dramatic as one might expect in an adjusting energy market.

6.2 The Factors Contributing to 1973-74 and 1979-80 Crises

Having explained the changes occurring in the energy market up to 1980, the next step is to examine the reasons for the oil price explosions which led to those changes and the possible reasons for the slow adjustments of the market, i.e. why there has been little sign of production increase from non-oil energy rsources.

Economists, however, are widely divergent in their explanation of the cause of oil crises.[6]

Some attributed the crisis to the natural tendency of oil producers towards cartilisation. In this way OPEC, therefore, effectively controlled the oil market and raised prices above the competitive level by restricting output.[7]

Others argue that oil price increases were brought about by the transfer of property rights from oil companies to oil producers.[8] As oil is the main source of foreign exchange earnings of almost all oil

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6 Demot Gately, A Ten-Year Retrospective : OPEC and The World Oil Market, Journal of Economic Literature, Vol. XXII (September 1984) pp.1100-1114.

7 C. Robinson and J. Morgan(1978) op. cit. Chapter one.

8 A. Johany, OPEC is not a Cartel: a Property Rights Explanation of the Rise in Crude Oil Prices, ph.D. Thesis, June 1978, University of California, Santa Barbara.

producers, they were motivated to prolong the life of such natural resources and price increases, therefore, are natural consequences.

The change was so dramatic that neither the cartel nor property rights alone would provide us with sufficient solution to the so - called oil crisis. Although OPEC governments managed to take over control from the oil companies and their revenue per barrel, consequently, increased somewhat, this was only due to a rapid expansion of the demand for oil. Paul MacAvoy argues that " there was no avoiding the substantial price increases required to clear the market of annual increase in crude oil demand".[9]

The market demand for crude oil was inelastic with respect to price, except in the long term, because of the absence of close substitutes. Reduction in the use of oil in response to a price increase relative to other fuels will take a long time to work through because they will require investment to either increase efficiency in the use of oil or to substitute other fuels for it.

In addition to the inelasticity of the demand curve, the supply of non-OPEC oil producers was so small that OPEC's share of total world oil export was 86.6% in 1972, a year before the crisis,(Table 6.5). Thus, the underlying shifts in market forces which worked their way through in favour of oil producers brought about the first oil price increase 1973-74.

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[9] Paul, MacAvoy, Crude Oil Prices, Ballinger Publishing Company, Cambridge, Massachusetts, 1982, chapter 3, pp.56-57.

OPEC as an organisation, however, does not have sufficient power to create such changes in the oil market. Although Middle East output restrictions did accelerate the oil price increase, the oil embargo was only meant to change the attitude of Western countries towards the Arabs- Israeli conflict.

During 1974 and 1975 the demand for oil fell below the 1973 level due to the world recession at that time. But by 1976 world oil demand and OPEC production were increased up to the 1973 levels. Saudi Arabia, however, managed to maintain the same price by cutting back its output in the light of a declining demand at that period. Saudi Arabia, therefore, led the way in direct production control by establishing the system of fixing light and heavy crude prices in its own interest, although the world was informed after a meeting of members that OPEC as a whole had set the price of crude oil. [10] Thus the kingdom managed successfully to increase the price of oil gradually from 1974 until 1979-80 when the second price explosion occurred.

Some economists attribute the crises to the backward - bending supply curve in the oil market, where demand was felt to be inelastic and to producers who were interested in higher revenues through cutting output and consequently raising prices. [11]

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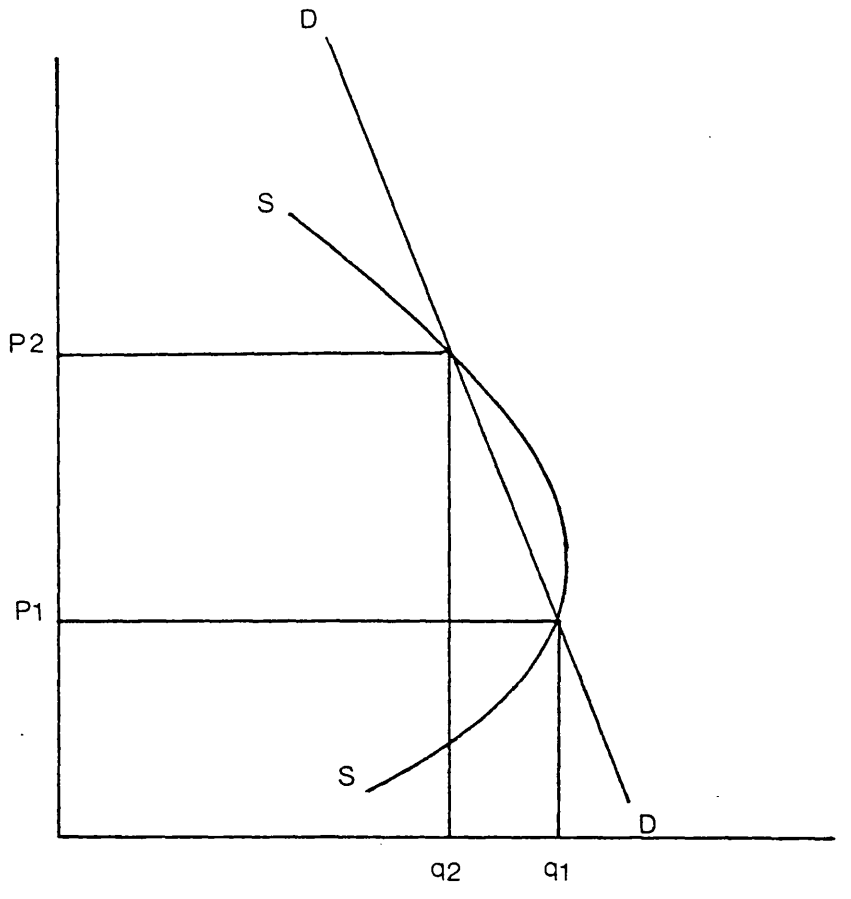
10 P. Stevens, The World Oil Equation and the future of Middle East oil. A paper presented to the Middle East Centre at the University of Durham in early December 1981.

11 David J. Teece, OPEC Behaviour: An alternative view, chapter 3, in James M. Griffins and David J. Teece, OPEC Behaviour and World Oil Prices, George Allen and Unwin, London 1982.



FIGURE(6·1) BACKWARD BENDING SUPPLY CURVE

This is, however, a very simple explanation concerned with a movement along the demand curve. It is very unlikely that with rising prices, there will be no change on the demand side so the curve will remain stable. It is more likely that the demand will be reduced by a backward shift. Furthermore, with an inelastic demand curve, the incentive for producers is to cut supply, so it must be a matter of the supply

curve shifting upwards too. When a change in oil prices relative to costs occurs, both the supply and demand curves are expected to shift.

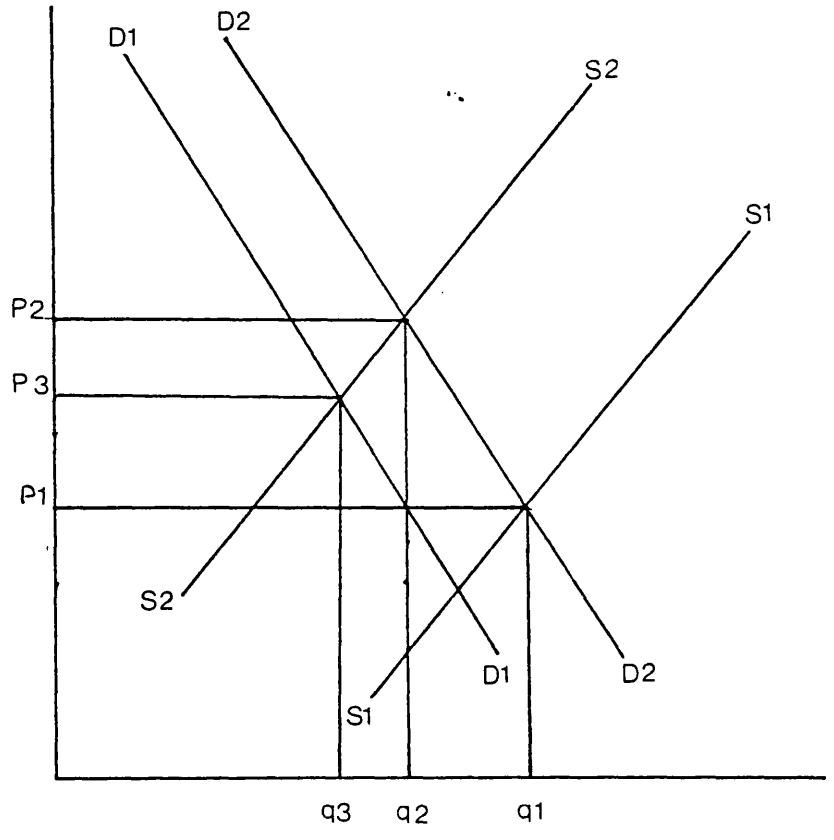


FIGURE (6·2) SHIFTING DEMAND CURVE IN RESPONSE TO A PRICE INCREASE

This simple explanation is inadequate in many ways and, there is no lack of alternative explanations for the 1980 oil price increase. The change in the trends, however, was so spectacular compared to the earlier period, that apart from any political factors there should have existed particular economic features and circumstances in the market to allow for such changes.

Others argued that the Iranian revolution which

resulted in a price increase from about $12 per barrel to about $32 per barrel was the factor that contributed to the second oil crisis. The Iranian revolution, however, reduced the world oil output by about 2.5 million barrels a day. This amount could have been offset by stock piles created by the oil companies.

Other economists argue that OPEC exploited its power and controlled the oil market through output reduction. The demand for oil increased during the late 1978 and 1979 as Iranian instability created fears amongst oil consumers and oil companies that the world oil market would face another supply disruption. Those fears led to a rise in demand for oil which was met by supply cuts by the leader of OPEC in 1979. The Saudi limit on production had created a supply uncertainty and made every buyer panic which resulted in a high demand and a price explosion.

To quote Morris Adelman:"The Iranian revolution is generally considered as the cause for the price jumps of 1979-1980, from about $12 to about $32 per barrel. But this cannot possibly be true. On January 20, 1979 - a day to remember - Saudi Arabia cut production from 10.4 to 8 MBD --- by mid February the price had jumped to over $31". [12]

He also added "Saudi Arabia led the regiment from behind, keeping its own official price usually $2 or so below the price for equivalent crudes sold by others ---

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12 M. Adelman, OPEC As A Cartel, in J M Griffin and D J Teece, OPEC Behaviour and World Oil Prices, George Allen and Unwin, London, 1982 p.47.

Saudi actions speak louder than words. The 1979 output cut back drove the price up to $32 from $12".[13]

Having explained the factors contributing to the oil crisis, the question ought to be asked as to how the depletion theory can explain those changes.

6.3 The Interpretation of the Oil Crisis in the light of the Depletion Theory

Although the depletion theory has already been explained in Chapter 4, a brief explanation will be useful to the reader in this context.

The depletion theory of non-renewable natural resource assumes an individual producer capable of exploiting a given known recoverable stock (R) of an exhaustible natural resource. He is able to determine the production level (q) over time subject to upper and lower limits dictated by the existing technology and without the interference of any institutional restrictions (.e.g government). The producer is faced with an investment decision: Whether to extract some quantity of the resource, sell it at the prevailing market prices and invest the revenues elsewhere at an interest rate reflecting the market opportunity cost of investment, which will yield some positive return, or leave it in the ground, thus investing in raw material stocks, in which case his return comes from an appreciation of the resource's price. This goal is

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[13] I. bid. p. 48.

assumed to be maximization of the NPV of his future investment programme, so he has to compare the NPV of the two investments.

The producer's expected net cash flow is his expected revenue stream obtained from selling future output, minus the expected cost stream, where costs include taxes and royalties to the government apart from extraction costs. Defining a net expected price stream (p) where p in any period is expected price minus expected cost, then his expected net revenue in year n is $P_n q_n$ and he wants to maximise his NPV

$$NPV = \sum_{t=0}^{n} \frac{(NR)t}{(1+r)^t} = \sum_{t=0}^{n} \frac{P_t q_t}{(1+r)^t}$$

subject to

$$\Sigma q \leq R$$

Given R, the significant variables are r (his discount rate which is uncontrollable), q, which is a policy instrument since he can control his production programme subject to the technical limits, and P. The cost component of P is outside his control to the extent that it includes taxes and is a function of the general price level, and P will be more of a policy instrument the more the market approximates to a monopoly. If, for

simplicity, we assume that net price is exogenous and that tax rates and inflation are known and can be easily taken into account, then his output decision becomes a function of his expectations about interest rates and prices. Thus, the level of production becomes a function of the anticipated rate of resource net price appreciation ($\dot{P} = \frac{dp}{dt}$) and the expected interest rate. The higher the expected interest rate is relative to $\dot{P}$, the greater will be the incentive to produce now and invest the revenues elsewhere, as this will bring higher returns than leaving the resource in the ground; in this case the opportunity cost of investing resources is high. On the other hand, the lower $\dot{r}$ is relative to $\dot{p}$, the lower will current production of the resource be, since in this case he expects the net resource price to rise at a percentage rate higher than the rate at which he is discounting the future, so that the amount he expects to gain by price appreciation if he invests in the resource is higher than if he invests elsewhere; now the opportunity cost of investing elsewhere is high. When $\dot{P} = \dot{r}$ then the producer is content with his output programme, i.e. resource owners are indifferent between providing and holding the marginal unit of the resource, since both alternatives bring the same return. There is also equilibrium in the assets' market since all producers are earning the same return on their assets in the ground and elsewhere. The producer, therefore, will determine his optimum inter-temporal resource allocation by adjusting his production profile over time in order to maximise expected net present value. In fact, it is

not strictly necessary to assume the producer is a net present value maximiser for $\dot{p}/\dot{r}$ to work; all we need to assume is that he has some preference for a greater, not necessarily maximum net present value, rather than a smaller one.

Having briefly examined the theory of resource depletion, it will be fruitful to apply this theory to the oil market in order to examine whether and how the theory can explain the pre-1973 trends of rising oil output and falling oil prices and the post-1973 dramatic changes in trends. In the 1960s, interest rates were abnormally high and control of oil operations was then in the hands of the oil companies which had, however, realised that it was only a matter of time before producing governments took control of oil depletion in their territories. [14] The companies time-horizons, therefore, were short and consequently $\dot{r}$ was high. At the same time expectations of declining prices were generated, probably originating in the substantial oil discoveries made by independent U.S. companies in the late 1950s, which occurred in the European and Japanese markets in the 1960s and coupled with a U.S. import restriction which lowered prices even further. The oil companies were operating in a more competitive environment than in the 1950s, which seemed to be bringing falling prices. Since this was also a time of very high discount rates and $\dot{P}$ appeared as zero or negative, companies tended to raise production not only

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[14] C. Robinson and J. Morgan (1978), op. cit. p.9.

to avoid the lower priced future, but also because per barrel profit in the future state owned oil was expected to be lower. Investment in resources seemed much less profitable than disinvestment, i.e. production and investment elsewhere. Thus in the 1960s, with $\dot{r} > \dot{P}$ the oil market was in disequilibrium, which set in motion a tendency towards equilibrium. That is, as production was raised, prices were lowered even more; however, as prices continued to fall, people probably realised that they could not go on falling infinitely, (i.e. that there was some lower limit). Hence the more prices fell, the more expectations increased about prices. At the same time, as oil production was raised to avoid the lower priced future, revenues from oil also fell.Thus on both sides ($\dot{p}$ and $\dot{r}$) there was a tendency towards equilibrium from the $\dot{r} > \dot{p}$ situation and this is how the $\dot{p}/\dot{r}$ theoretically should be interpreted (i.e. that at any point in time there is a disequilibrium which sets in motion a tendency towards equilibrium). So why was equilibrium not reached, or even approached, and why instead were the trends reversed so dramatically after 1970?

During the early 1970s, a significant change came over the market and this was the formation of expectations of future oil shortages and hence of future oil price increases. This was not new since fears of energy shortage had been expressed as long ago as Hotelling's time. What was different from Hotelling was the creation of the belief of physical exhaustion of resources. Numerous attempts to forecast the future

results of man's economic activity appeared in the early 1970s, because the long-sustained economic growth of the 1950s and 1960s had created fears about this growth's impact on the natural environment, and more specifically fears that such growth increased both inputs of materials from the environment and outputs of waste to the environment, leading to a global disaster. Also, in the early 1970s some economists drew the attention to the "Limits to Growth" which tried to explain that if the world went on depleting resources at current rates then such resources would run out; and that the environment could not tolerate more waste causing some catastrophe to happen.

Others argue that the idea of an upper limit on the potential capacity of the environment in the very long run is conceptually sound. M. Adelman (1976) argues that oil is an inexhaustible raw material in a sense that it belongs to a large combustible group which include seawater, granite and wind among others. When oil prices rise, the consumer will switch to other energy sources and consequently the stock of oil will never be exhausted.[15]

According to this view, technology, however, detemines the magnitude of the oil stock; For example, exploration technology determines the size of the known materials in the ground; recovery technology dictates what is usable from the environment, while recycling technology dictates the feedback of waste into the

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15 M. Adelman, Scarcity, Economics and Politics, The Quarterly Review of Business Economics, 1976, pp. 7-18.

materials stock. So, at any given point in time, world energy resources are dependent on the existing state of technology. The idea of "limit to growth" is to be rejected as the stock of resources depends on the state of technology .

Even as one would tend to argue that oil is inexhaustible as a resource base energy, it is in fact finite. [16] Although new technology might add to the amount of oil recoverable, it cannot increase the stock in the ground. Hence oil, as a natural resource, is depletable.

Concerning oil substitutes, technology has yet to produce a very close substitute for oil that has the inherent characteristics which are peculiar to crude oil.

A. B. Louvins argues that " Ever since the 1960s, it has been clear that replacing Persian Gulf oil and North American onshore oil and gas in the long run with nuclear power, coal- based electricity or synthetics, tar sands, oil shale, or even many solar technologies would cost several times as much as oil costs on the world market.[17]

Oil, therefore, is an exhaustible natural resource but the argument that exhaustion would limit economic growth is conceptually interesting since a question mark hangs over it. This is so because the growth in technology explores new areas in development especially

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16 A.B.Louvins. Soft energy Path,Penguin Books,1977,p.19.

17 I.bid.p.6.

in the industry . It is highly unlikely that a situation could be envisaged where the world industry would become extinct due to the unavailability of natural resources.

Also important is the trend in the economic transformation phase as reflected by prices relative to costs, which determines the potential supply of and demand for energy resources at any point in time. Supply will be determined by the costs of exploitation, taxes, etc. relative to the price level, and demand will respond with lags to price changes. When resources become limited, their prices will rise and the growth of consumption will fall and, therefore, the "Limits to Growth" argument which states that resources are limited but that growth rates of consumption will remain the same is to be rejected, because the argument is inconsistent and does not correspond to what economists would expect from a situation of scarcity.

Still the fact is that such studies in the early 1970s changed expectations for lower prices in the 1960s to expectations for rising prices. At the same time the change in the control of production - that is, the price and output decision - from the oil companies to the governments of the oil- producing countries changed interest rates from being very high in the 1960s, to low in the 1970s, not necessarily because the outlook of a producing government is longer than that of a company, but because the companies' horizons were shorter in the 1960s when expropriation was in prospect, than the governments' in the 1970s.

Certainly OPEC did accelerate the price rises of

1973-74, but it seems doubtful whether the increases in oil prices and hence in producer's revenues could have been managed without the economic features of the oil market in the early 1970s, even though political factors were also important. It was the change in expectations which led to $\dot{p} > \dot{r}$ and hence created the incentive to producers to hold output or simply threaten to do so, which in turn created expectations of future price increases and made producers restrict output further. The 1979-80 price increases can also be explained in terms of the resource depletion theory, because at that time the Iranian revolution created expectations of oil scarcity in the future and hence of oil price increases; $\dot{P}$ was thus raised relative to $\dot{r}$ and the incentive again was to restrict or threaten to restrict output and hence raise prices.

In the $\dot{p} > \dot{r}$ disequilibrium situation the energy market again has the tendency to adjust and move towards equilibrium. When prices are raised at first, consumers expect them to go on rising but as prices do so, people tend to shift away from oil by conserving energy and developing substitutes, which will increase the price elasticity of demand for oil in the long run. Thus, eventually people come to realise that prices cannot go on rising indefinitely but that there is an upper limit to this increase. The more prices rise now, the less people expect them to rise in the future, (i.e. price expectations are dumped downwards because consumers come to believe that most or all of the increases that could happen towards the upper ceiling - which may be the

price of substitutes - have already occurred). At the same time, consumers' action (i.e. the rate at which substitutes are developed) affects the producer's price expectations; the cost of substitutes may set an upper limit to these prices, and then sometime before the limit is reached $\dot{p}$ will decline and eventually be less than $\dot{r}$; hence on the price expectation side there is a tendency towards equilibrium. On the discount rate side, as producers hold oil back in the short run, and hence raise prices, oil revenues will increase because of the price-inelastic demand curve for oil; hence $\dot{r}$ will tend to increase. Thus, on both $\dot{P}$ and $\dot{r}$ sides there is a tendency towards equilibrium.

6.4 Market Adjustment to Oil Price Increases

The principal changes in the world energy market since 1970 examined above, suggest that adjustment to higher oil prices has begun but the speed of adjustment has been rather slow. On the demand side, world energy demand slowed down after 1973 but consumption only fell after the second price rise of 1979-80. Oil demand was also depressed due to higher relative prices. The extent to which oil consumption has fallen in the household sector, however, may have been exaggerated, since the statistics do not include the stocks accumulated by consumers when prices are expected to rise. On the supply side there has been little sign of significant competition from non-oil sources of energy. Thus, it is worth examining the constraints on the adjustment

process, not only to understand why it is slow, but also to gain some information as to what the future may hold.

The first delaying factor relates to the price signals received by consumers. One reason for the slow adjustment to the large crude oil price increases has been that real consumer prices of oil and other fuels have risen, much less than expected. The C.I.F. price of crude, for example, has risen less than the F.O.B. price. Oil has to be transported to the consumer countries, refined and distributed. As the world tanker market was depressed, the cost of transport fell somewhat ; also refining, marketing and distribution costs have risen much less compared to the export price of crude from the producing countries.

Another obstacle to market adjustment has been the attempt of some governments to protect their citizens from higher energy prices; e.g. in the U.S.A., and in Britain where household gas prices have been held down, in Canada where crude oil prices have been kept below the world average level - and in other countries where fuel price subsidisation has taken place.

The second reason for the slow adjustment is that the duties levied on oil products have fallen in real terms, while there has been rapid general inflation since 1973 which has limited the energy price rises relative to the general price level. So in the major OECD countries the percentage of tax on the price of gasoline has fallen from 168 per cent of the price to 82 per cent of the price between 1973-80. [18] Taking Britain as an example, the real price of heating- oil in

the household sector has increased by 90 per cent between 1973-80, the real price of all household fuels by 20 per cent and of gasoline by 28 per cent.[19] In the same period the real price of fuel oil tripled and the real price of industrial fuels doubled. Hence, though the oil price increases were large especially in the industrial sector, they were less dramatic than the rises in the F.O.B. price of crude, which in the same period multiplied five times in real terms.

Having explained the reasons for the price signals received by consumers being lower than crude price increases, it may be useful in this context to examine some inherent features of the energy market that tend to delay adjustment to a price increase, namely time lags on the demand and supply sides of the market.

On the demand side, one has to realise that fuel demand is a derived demand, i.e. fuels depend for their use on the ownership by consumers of a durable fuel-using asset - even though fuels are non-durables. Durable goods - household appliances for example, cars etc. - are capital assets that are bought and held in stock for a long time period - longer than non-durables such as food - during which they depreciate but continue to yield services. Given a set of relative prices of durable and real income, consumers have a certain demand for the services of durable goods, from which an equilibrium or desired stock is derived, towards which

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18 International Energy Agency, World Energy Outlook, OECD Paris 1982, p. 82.

19 Derived from the Digest of United Kingdom Energy Statistic,1981.

consumers will attempt to move. So when energy prices rise relative to prices in general and relative to one another, there will be significant lags before the consumers bring their actual stock of fuel-use into line with the stock desired on the basis of the new prices. Adjustment to the desired stock takes place slowly partly by replacement sales (i.e. sales to owners who want to keep the service constant) and partly by sales to new owners. In the case of the car market, for example, it takes time before more efficient engines are designed and more time before the new designs become a significant part of consumers' stock. Furthermore, to save energy in response to an oil price increase will take time because large investments will be required for both energy conservation and fuel switching, and such investments bring larger real price increases before they become economic.

On the supply side what one would expect after oil price rises relative to costs is: firstly, a tendency by producers to hold back marginal production, leaving oil in the ground, thus affecting the inter-generational distribution of resources; secondly, as prices rise and the gap between prices and costs widens, any one barrel of oil will be more profitable, hence for any given reserve of oil in the ground, the proportion worthwhile recovering will increase, so even if producers decide to hold back the marginal barrel of oil for the future, the eventual amount of oil recovered will rise; thirdly, as prices rise expectations for further price increases are eventually dampened down so that there will be an

increased tendency for exploration and eventual production in high cost area. In the U.S.A., for example, there has been a boost in explorations and new discoveries since 1977.20 There is, however, a long lead time between exploration and exploitation.

Since all fuels are to some extent substitutes, an increase in oil prices is expected to lead to a rising price of fuel, hence in the long term there will be a supply-increase effect on other forms of energy, namely, coal, nuclear power and renewable resources. As oil prices rise relative to cost, it is expected that investment in substitute energy forms would become profitable since their prices rise too. Intuitively, substituting other energy forms for oil will be a very long process, because to bring a new power station or a coal mine into operation takes about ten years, while the commercial application of renewables is believed to be a long way off. Thus to some extent, the slow supply response to the changed oil prices is inevitable because of the time taken to exploit major projects. At the same time, the supply reaction has been slowed down considerably by an increasingly important phenomenon concern about the environment. It is true that many energy supply facilities tend to be obstructive and represent potential pollution hazards (e.g. Chernobyl), so that objections to such facilities are expected to delay their introduction in the future as it has happened in the past.

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20 S. A. Schneider (1983), op. cit. chapter 11.

Despite the slow adjustment of the energy market to oil price increases, the determination of the industrial world to reduce the dependency on oil and other factors have created a remarkable change in the energy market during the early Eighties. These changes will be discussed in detail in the next part of this chapter in addition to the forces that have been set in motion in creating them.

6.5 World Energy Market 1981-86

The two oil price increases during the periods of 1973-74 and 1979-80 have created remarkable changes in the world energy market and the world economy as a whole. It has affected the economic growth in the industrial world by rising government deficits, inflation, sharply increased transfer payment and balance of payments problems. These factors, however, have forced the industrial countries to adopt certain measurements to reduce their dependence on oil by increasing the consumption of other energy sources. Coal consumption, for example, has been rising at a rate of 2.8 per cent compound on average, during this period. Like-wise nuclear energy by 2.2 per cent compound on average. When compared to other fuels, therefore, oil consumption has shown a remarkable fall. Table 6.11 indicates that oil consumption has been falling at a rate of 0.7 per cent compound on average. Falling oil consumption was brought about by higher prices of oil and oil products relative to other energy prices,

combined with other factors such as the recession in industrial countries, energy conservation policies and the substitution of alternative fuels, which altogether led to a substantial fall in the demand for oil and created a glut in the international market. The fall in consumption was concentrated in the industrial countries, mainly, U.S.A., Canada and Western Europe.

Tables 6.10 and 6.11 indicate that the consumption of oil in developing countries maintained its upward trend and rose by 1.8 per cent compound on average between 1981-84. This increase, however, was insignificant when compared with the consumption reduction in the industrial countries which caused demand to fall. As a result, the world demand for oil continued its downward trend and fell from 50.3 million barrels per day in 1979 to 43.3 million bpd in 1983. Although the demand for oil in 1984 had witnessed a reversed trend (because of economic recovery in the main oil consuming countries), the oil market continued to remain fundamentally weak. Increasing oil production from the North Sea and the Soviet Union, quota violations by some OPEC members, widespread offering of price discounts, and refiners' comfortable supply position, were the factors which contributed to the weakness of the oil market.

In response to a demand fall, the supply of crude oil, on the other hand, fell too, and the reduction has been mainly in OPEC production. Table 6.13 indicates that OPEC output has been falling at a rate of 8.2 per cent a year compound on average. This fall in OPEC

production started in September 1980, in the wake of the Iran-Iraq war. The share of OPEC in the world total production declined from 40 per cent in 1981 to only 29.9 per cent in 1985 which obviously indicates the downward trend of OPEC's share in world total.

Production of non OPEC countries, however, maintained its upward trend during this period. Between 1981-85 their share of world total increased by 2.8 per cent compound on average. With this increase in mind, falling demand for oil and other factors which were mentioned earlier, have put pressure on OPEC members to reduce the official price of the market crude, Arabian light, from $34 to $29 per barrel and to fix a ceiling of 17.5 million barrels per day for total OPEC production for the rest of 1983.[21] An OPEC agreement in London, March 1983, aimed at stabilizing the international oil market which has deteriorated during the early Eighties. Despite these price reductions, the situation of the oil prices did not improved in 1984. There was still imbalances between supply and demand as non-OPEC oil producers maintained their increasing share of production, especially the Soviet Union, Norway and the United Kingdom. In addition to those factors previously mentioned, a price-cut of $1.50 a barrel by the Soviet Union for its export crude and the OPEC decision in July 1984 to allow Nigeria to increase its output temporarily beyond its quota, were additional factors accentuating the market weakness. Furthermore,

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21 S A M A, Annual Report, 1983, p. 21 ; Also, see I E A, Annual Oil Report, Paris 1984.

Norway reduced the official price of its North Sea crude by $1.50 to $28.60 per barrel on 15th October 1984. Two days later, Britain also cut the price of her North Sea oil by $1.35 to $28.65 per barrel. OPEC, in an attempt to maintain oil prices, decided to reduce its production ceiling by 1.5 million barrels per day to 16 million bpd, while leaving its base price unchanged at $29 a barrel.[22]

The imbalance between the demand for and the supply of crude oil continued in 1985 as the share of non-OPEC countries continued to increase while demand for oil continued its downward trend. In the light of falling demand for OPEC oil to a very low level, many member countries experienced a very low level of revenue. They realised that the self-imposed policy of output control was not successful as output was increased by non-OPEC members. Consequently, most members offered a price-discount to the oil companies operating within their borders which, in the end, resulted in quota violations. Such action had reduced the volume of Saudi crude oil exports to a very low level and its revenue in turn, experienced a severe drop. Saudi Arabia, therefore, in the middle of 1985, ended its commitment to defend oil prices and abandoned its role as a swing producer.

R. Mabro and N. Ait Lanussine argued that "by putting the swing-supplier in the position where it was no longer able to perform this task, all exporters, OPEC

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22 SAMA, Anual Report, 1985, p.24.

and non-OPEC, have together destroyed a system which had served them very well".23

Consequently, a price- war was set in motion by Saudi Arabia when it began negotiating net back agreements with oil companies. The aim of this agreement was to increase the volume of the Kingdom's crude oil export and to point out to other producers that cooperation on prices and production is required to avoid competition against each other.

In the wake of OPEC's decision in December 1985 to maintain its member share of the oil market, the oil spot and future markets on both sides of the Atlantic suffered what traders regarded as a price collapse. On December 10th, 1985, North Sea crude was offered at $24.20 a barrel for January delivery. The oil price continued its downward trend during early 1986, as non-OPEC producers are output maximizers and OPEC members' new concern is to seek an increased market share of oil production. The supply of both sets of producers, however, has exceeded the demand at the ruling price. OPEC output is currently running at at least 1.5 million barrels a day above OPEC ceiling quota of 16 million barrels a day. So, imbalances between supply and demand, still existed during early 1986 which put pressure on oil prices to plumped further. In February, 1986, North Sea oil was traded at below $16 per barrel. On April 2, 1986, oil prices reached their

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23 R. Mabro and N. Ait-Laoussine, We are Worried, Middle East Economic Survey, Mondy 27th January 1986,p.7.

lowest level, $9.80 per barrel, and increased to 14.25 on the 8th of the same month.

The collapse of oil prices was brought about by OPEC, non-OPEC producers and other factors. Since the first oil crisis in 1973-74, there were forces which were set in motion to increase the elesticity of oil demand by increasing the consumption of oil substitutes. In the light of this action, what OPEC should have done, was to reduce its oil price and increase output gradually in order to secure both the market shares and revenues. But OPEC has done otherwise, they increased oil prices in 1979-80 which worsened the situation. High oil prices were an incentive to consumers to take further measures to reduce their dependency on oil. The second factor which contributed to dampened oil prices was the unco-operative behaviour of non-OPEC producers. They were output maximizers, and until recently they reaped the benefit of high oil prices without apparent concern for future consequences. When demand for oil fell during the early Eighties, non-OPEC producers increased their share of the oil market. It seems that they have ignored the fact that one country or one group would not be able to continue to defend prices for a long time without the cooperation of others. The ignorance of non-OPEC producers to OPEC appeals to reduce their output has provoked OPEC to declare a price war in 1985, which worsened the situation. The declaration of a price war has created a situation where both sets of producers are losing out on the revenue front. Regardless of whether they are developed or less

developed countries, falling oil price will reduce their revenue and will create a balance of payment problem.

The current instability of the oil market proves the prediction that future markets, will not only be hard to predict, but inaccurate. Some observers still have faith in OPEC to bring back oil price stability through production control. This view, however, is arguable since most of OPEC´s members are less-developed countries which depend mainly on revenue from oil exports. Reducing these will affect their economic development programmes as they will lose out on much needed revenue.

It remains to be seen whether OPEC and non-OPEC oil exporters can reach an agreement according to which oil prices and market share will be settled. Such an agreement might be useful if consumer needs and a reasonable price level are considered. Market power, however, may decide what will happen in the future as a suitable solution to the current crisis.

TABLE (6.1)

World Consumption of Commercial Energy
for Select Years (Thousands Metric Tons).

	1950		1970		1973		1979		1980	
	Per Capita Energy Kg/ Head	Total Energy mtce	Per Capita Energy Kg/ Head	Total Energy mtce	Per Capita Energy Kg/ Head	Total Energy mtce	Per Capita Energy Kg/ Head	Total Energy mtce	Per Capita Energy Kg/ Head	Total Energy
Developed MKT. Economy	3168	1830	5708	4141	6177	4628	6329	4961	6035	4799
Develop-ing MKT. Economy	112	123	301	517	357	659	448	958	459	1004
Centrally Planned Economy	558	453	1466	1783	1641	2085	1978	2715	1977	2745
World Total	969	2406	1758	6430	1907	7372	2011	8634	1955	8548

Source: Year Book of World Energy Statistics, United Nations, 1980.

TABLE (6.2)

World Consumption of Commercial Energy
for Selected Years.

	1950		1970		1973		1979		1980	
	M.T.C.E	% of Total	M.T.C.E	% of Total	M.T.C.E	% of Total	M.T.C.E	% of Total	M.T.C.E	% of Total
Solid Fuels	1472	61	2184	34	2235	30	2637	31	2669	31
Liquid Fuels	648	27	2798	44	3426	46	3867	45	3709	43
NAT. Gas	243	10	1293	20	1525	21	1842	21	1871	22
Hydro. Nucl.	42	2	154	2	186	3	288	3	299	4
TOTAL	2405	100	6429	100	7372	100	8634	100	8548	100

Average Annual Compound Rates of Increase (%)

	1950-73	1970-73	1973-80	1979-80	1973-79
Solid Fuels	1.8	0.7	2.6	0.01	2.7
Liquid Fuels	7.4	6.9	1.0	-0.04	2.0
Nat. Gas	8.2	5.6	2.9	0.01	3.2
Hydro.Nucl.	6.6	6.4	7.0	0.03	7.5

Total	4.9	4.6	2.1	-0.01	2.6

Source: Year Book of World Energy STATISTICS, UN, 1980.

TABLE (6.3)

World Energy Consumption

	1965		1973		1979		1980	
	M.T.O.E	% of Total	M.T.O.E	% of Total	M.T.O.E	% of Total	M.T.O.E.	% of Total
Oil	1530	38.7	2798	47.3	3124	45.0	3001	43.5
Solid Fuel	1525	38.6	1668	28.2	1976	28.5	2007	29.1
Nat. Gas	647	16.4	1066	18.1	1273	18.3	1297	18.8
Nuclear	6	0.2	49	0.8	153	2.3	169	2.5
Hydro-Elec.	242	6.1	332	5.6	413	5.9	422	6.1
Total	3950	100	5913	100	6939	100	6896	100.0

Source: BP Statistical Review of World Energy, 1984.

TABLE (6.4)

World Oil Production 1960, 1973 and 1980

	Million Tonnes					% of total increase	% of total increase
	1960	1973	1980	increase 1960-73	increase 1960-80	1960-73	1960-80
North America	410.5	621.3	565.8	210.8	155.3	11.8	7.8
Latin America	194.9	272	298.6	77.1	103.7	4.3	5.2
Middle East	261.8	1052.5	928.1	790.7	666.3	44.4	33.4
Africa	13.8	290	301.7	276.2	287.9	15.5	14.5
(CPES)	167.2	503.1	727.6	335.9	560.4	18.8	28.1
Others	42.4	132.7	261.7	90.3	219.3	5.2	11.0
Total	1090.6	2871.6	3083.5	1781	1972.9	100.0	100.0

1. Average Annual Compound Growth Rate of World Oil Production between 1960-73 = 7.7

2. Average Annual Compound Growth Rate of World Oil Production between 1960-80 = 5.3

Source: BP Statistical Review of World Energy, 1984.

Table (6.5)

OPEC Exports of Crude Oil, 1972

OPEC Members	Thousand Tonnes	per cent of world total
Algeria	46110	3.3
Ecuador	3490	0.3
Gabon	5360	0.4
Iraq	68260	4.9
Iran	225860	16.4
Indonesia	41000	3.0
Kuwait	160130	11.6
Libya	106790	7.7
Nigeria	85410	6.2
Qatar	23450	1.7
Saudi Arabia	259900	18.8
Venezuela	111730	8.1
United Arab Emirate	58140	4.2
TOTAL OPEC	1195630	86.6
WORLD TOTAL	1379870	

Sources: Statistical Bulletin 1976 and 1980,Nos.7 and 11, Ministry of Petroleum and Mineral Resources, Saudi Arabia.

TABLE (6.6)

Annual Average F.O.B Export Price of Light Arabian Crude Oil, Arabian Gulf, Ras Tanura, US$ Per Barrel.

Year	Posted or Official Price	Real or Posted Price
1960	1.78	5.9
1961	1.71	5.5
1962	1.70	5.4
1963	1.78	5.7
1964	1.82	5.6
1965	1.79	5.5
1966	1.78	5.4
1967	1.78	5.4
1968	1.82	5.5
1969	1.78	5.4
1970	1.74	5.1
1971	2.24	6.1
1972	2.42	6.3
1973	3.27	7.1
1974	11.58	20.7
1975	11.53	18.3
1976	12.38	19.6
1977	12.39	17.9
1978	12.70	16.1
1979	17.26	19.2
1980	30.22	30.22

Sources:

1) Prices are obtained from Ministry of Petroleum and Mineral Resources, Saudi Arabia.
2) Also See M. Adelman, The World Petroleum Market, 1972, Ch 4, 5.
3) United Nations Monthly Commodity Price Bulletin 1960-84.

Note: Posted Prices from 1960-74, Official Setting Price from 1975 onwards.

TABLE (6.7)

Producing Government Revenues per Barrel

Light Arabian Crude Oil.

Year	US $	US $ 1950 real price
1950	0.28	0.28
1960	0.68	0.55
1965	0.81	0.63
1970	0.89	0.61

Source: C Robinson, "Energy Depletion and The Economics of OPEC", 1975.

TABLE (6.8)

World and OPEC Oil Production

Thousand U.S. Barrels per day.

Year	World Output	OPEC Output	World Excluding OPEC	Share of OPEC %
1971	48132	25328	22804	52.6

		6.44		
1972	50739	27089	23650	53.4
1973	55414	30989	24425	55.9
1974	55925	30733	25192	54.9
1975	53051	27123	25928	51.1
1976	57265	30454	26811	53.2
1977	59635	31069	28566	52.1
1978	60337	29990	30347	49.7
1979	62812	30796	32016	49.0
1980	59670	26897	32773	45.1

Sources: Petroleum Statistical Bulletin 1976 and 1980, Nos.7 and 11, Ministry of Petroleum and Mineral Resources, Saudi Arabia.

TABLE (6.9)

Primary Energy Consumption M.T.O.E

	1965	1973	1979	1980	% change 1973/1980
North America	1452.2	2003.8	2136.0	2068.1	0.4
Latin America	141.4	236.5	315.0	330.0	4.8
Western Europe	824.3	1240.9	1327.6	1279.4	0.4
Middle East	39.7	87.1	107.4	117.1	4.2
Africa	70.3	98.2	153.0	164.7	7.6
Japan	152	347.7	369.9	359.6	0.4
South & South East Asia	110.7	195.8	273.8	290.2	5.7
Australasia	43.0	66.6	86.1	85.9	3.6
Centrally Planned Economics	1111.5	1636.8	2171.1	2199.8	4.3
TOTAL	3945.1	5913.4	6939.9	6894.8	2.2

Source: BP Statistical Review of World Energy, June 1985.

TABLE (6.10)

World Oil Consumption

	1973 Million Tones	% of Total	1980 Million Tones	% of Total
North America	901.7	32.2	881.7	29.4
Western Europe	748.9	26.8	680.1	22.6
Japan	269.1	9.6	327.7	7.9
Australasia	34.8	1.3	36.4	1.3
Centrally Planned Economies	467.9	16.7	644.3	21.4
Latin America	160.3	5.7	211.8	7.1
Africa	49.5	1.8	71.9	2.4
Middle East	62.2	2.2	82.0	2.7
South and South East Asia	103.6	3.7	154.6	5.2
TOTAL WORLD	2798.0	100.0	3005.0	100.0

Source: BP Statistical Review of World Energy, June 1985.

TABLE (6.11)

World Energy Consumption 1981-84

	1981		1982		1983		1984	
	M.T.O.E	% of Total	M.T.O.E	% of Total	M.T.O.E	% of Total	M.T.O.E	% of Total
Oil	2902.8	42.3	2824.8	41.2	2801.4	40.4	2844.5	39.5S
Solid Fuels	2002.9	29.2	2047.1	29.8	2101.0	30.3	2179.6	30.3
Natural Gas	1320.7	19.3	1315.5	19.2	1325.5	19.0	1409.9	19.6
Nuclear	199.0	2.9	218.7	3.2	240.3	3.5	282.2	3.9
Hydro-Electricity	431.6	6.3	451.6	6.6	475.0	6.8	485.4	% 6.7
TOTAL	6857.0	100.0	6857.7	100.0	6943.2	100.0	7201.6	100.0

Source: BP Statistical Review of World Energy, June 1985.

TABLE (6.12)

World Oil Consumption 1981-84

	1981		1982		1983		1984	
	Million Tones	% of Total	Million Tones	% of Total	Million Tones	% of Total	Million Tones	% of Total
North America	827.7	28.5	778.4	27.6	773.1	27.5	791.4	27.8
Western Europe	633.7	21.8	604.9	21.5	586.6	20.9	591.0	20.8
Japan	233.9	7.7	207.8	7.3	208.2	7.4	214.6	7.5
Australasia	35.8	1.2	34.9	1.2	33.7	1.2	35.5	1.3
C.P.E	649.2	22.4	650.0	23.0	652.8	23.3	650.2	22.8
Middle East, Africa and Others	532.5	18.3	548.8	19.4	548.0	19.6	561.8	19.8
TOTAL	2902.8	100.0	2824.8	100.0	2801.4	100.0	2844.6	100.0

Source: BP Statistical Review of World Energy, June 1985.

TABLE (6.13)

World and OPEC Oil Production 1981-84
Thousand Barrels Per Day

Year	World Total	OPEC Production	Non-OPEC Production	Share of OPEC %
1981	56016	22540	33476	40.0
1982	53266	18660	34531	35.0
1983	53018	17416	35602	32.8
1984	54359	17442	36917	32.1
1985	53391	16011	37380	29.9

Sources: Oil and Gas Journal, March 1982, 1983, 1984 and 1986.

CHAPTER SEVEN

OIL DEPLETION AND ABSORPTIVE CAPACITY IN SAUDI ARABIA

Saudi Arabia is one of the oil exporting countries which depend mainly on oil exports as a main source of revenue. Cheap oil prices in the 1950s and 1960s provoked these countries to demand high oil prices from oil companies. In the 1970s dramatic changes occurred in the oil market; oil producers controlled the production and price policies. Consequently, oil prices increased as a result of this in addition to an increasing demand for oil. These factors have helped oil producers earn huge amounts of revenue, most of which have been directed towards economic development.

Saudi Arabia has launched ambitious development plans in order to achieve rapid economic growth and reduce the dependence on oil revenue by increasing the share of other sectors in the economy.

The aim of this chapter, therefore, is to examine to what extent oil revenue has been utilized. In other words, whether or not oil depletion and its subsequent revenue has had a positive impact on economic development in Saudi Arabia in terms of its absorptive capacity.

The contents of this chapter will be divided into the following section:

Firstly, the definition and measurements of absorptive capacity will be examined.

Secondly, an analytical background to the concept of absorptive capacity and domestic investment planning will be illustrated in order to examine the utilization of oil revenue in the Saudi economy.

Thirdly, a macroeconomic model will be constructed to measure the sectoral absorptive capacity of the economy.

Finally, suggestion will be made of some policy implications which might be useful in guiding policy makers in planning and controlling the oil sector in such a way that its contribution can be maximised.

7.1 Definition of Absorptive Capacity

The problem of absorptive capacity could be defined as a constraint on economic development when the two concepts are well defined. It might refer to the inability of the economy to absorb capital investment funds efficiently. The problem of LDCS, however, is not the scarcity of capital investment funds but the observed low rate of return. Sayre P Schatz (1965) argues that the problem is not the dearth of capital but in fact the shortage of viable projects. [1]

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[1] S. P. Schatz,"The Capital Shortage Illusion, Government Lending in Nigeria", Oxford Economic Papers, July, 1965, Vol. 17, No 2.

Economists, however, have defined the concept from different points of view where there exists a wide range of definition of absorptive capacity.

One of the most comprehensive definitions of absorptive capacity has been introduced by Adler (1965). The definition of absorptive capacity according to Adler was .. "That amount of investment or that rate of gross domestic investment as a proportion of GNP, that can be made at an acceptable rate of return, with the supply of cooperant factors considered as given". [2] The centre of Adler's definition of the concept of absorptive capacity is the idea of an efficient use of capital. But how can the "acceptable rate of return" be judged?

The familiar method is to compare the rate of return that could be realized from installing an incremental unit of capital with the same one outside the country. That is to say, the rate of return on capital which will be invested domestically should be equal to the return on the same capital invested abroad.

The concept of absorptive capacity, however, depends on the diminishing marginal productivity as the rate of return on marginal invested capital diminishes with the increment of each extra unit of capital. This decrease on the rate of return of investment is assumed to continue until it reaches the acceptable rate which varies from one sector to another and from one country to another.

It is argued, however, that the concept of an

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[2] J. H. Adler, Absorptive Capacity, (Washington, D.C.), The Brookings Institution, June 1965, p. 5.

acceptable rate of return has not been well specified by Adler. what should be considered is the social rate of return as opposed to financial rate of return, since the financial rates of return disregard investment in human capital which is essential to the process of economic development.

Concerning the supply of cooperant factors such as skilled labour and managerial talents ... etc., Adler's interpretation seems to deny the possibility of factor mobility or substitution of one factor of production for another. Thus his assumption seems to be valid within the context of a closed economy.

One of The most recent definitions of absorptive capacity which covers most of the literature was the one introduced by R. El-Mallakh and A.Jacob(1981), they write: "The absorptive capacity of a country is the ability of the domestic economy to absorb resources at an acceptable rate of return within a given period". [3] According to this definition, we should specify the nature of resources which ought to be absorbed. A distinction, therefore, should be made between invcstable funds and total financial resources, between the supply of financial resources and its conversion into physical goods. Having specified the nature of financial resources, the desirability then depends on using the concept of absorptive capacity.

Another definition of absorptive capacity could be

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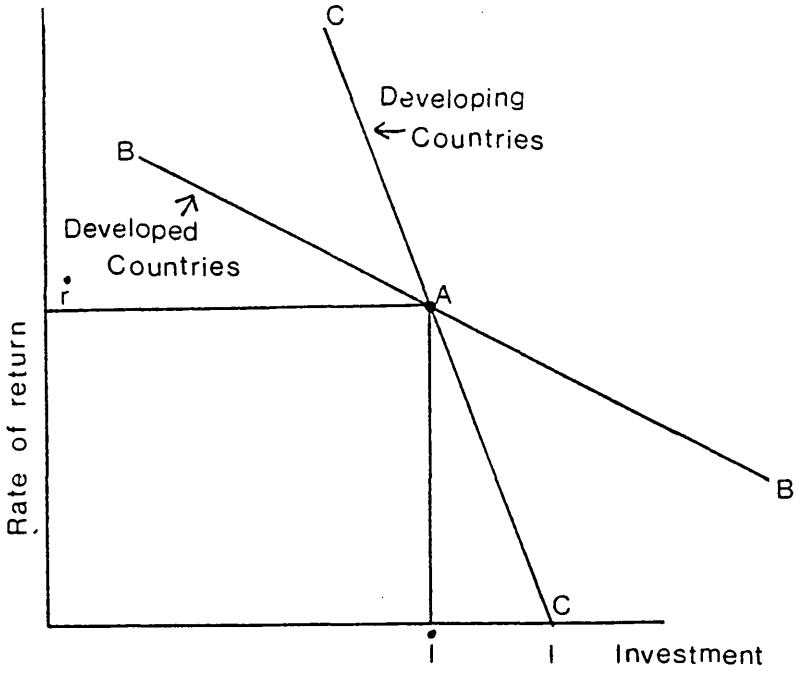
[3] R. ElMallakh and A. Jacob, The Absorptive Capacity of Kuwait": Domestic & International Perspectives, Lexington Books 1981, p. 2.

taken into consideration when we consider the case of oil surplus funds in some oil- exporting countries. The absorptive capacity in this context, may be defined as the ability of the economy to absorb oil revenue in a productive manner. Since the market size in those countries is limited, the concept of absorptive capacity could be used to describe the ability of these countries to utilize the foreign exchange effectively.

7.2 Measurement of Absorptive Capacity

Absorptive capacity is usually measured in terms of the rate of return on capital investment. The basis for the rate of return owes its origin to Keynes "marginal efficiency of capital" according to which the concept of absorptive capacity is reduced to a schedule relating investment to the expected rate of return. Figure (7.1) explains this method of measurements.

FIGURE 7.1



MEASUREMENT OF ABSORPTIVE CAPACITY

In this figure, investment (I) is measured along the horizontal axis, whereas the expected rate of return (r) is measured along the vertical axis. Curve (CC) relates investment to the rate of return in developing countries and curve (BB) relates investment to the rate of return in developed countries. The different economic conditions in these countries are expressed in the different shapes of the above curves. To the left of the intersection point (A),the (CC) curve is above the (BB) curve indicating that investment up to (I^*) would yield a higher rate of return in developing than in developed countries. Adler pointed out that "there is circumstantial and some direct empirical evidence that in less developed countries the return on existing stock of capital is high and that it is reasonable, therefore, to conclude that the expected rate of return on some additional investment also is high"[4] The shape of these two curves can be changed if the supply of the cooperant factors are improved in LDCS to the level of that prevailing in developed countries.

Beyond point (A) however, the situation is different. The shape of curves (BB) and (CC) reflects that the decline in the rate of return in developing countries is faster than one that could be prevailing in developed countries. The reason behind this is that there are absorptive capacity constraints in LDCS which do not exist in developed countries. Thus, in Figure

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[4] J. H. Adler,(1965) op.cit. pp.2-3 .

(7.1), the absorptive capacity is equal to (I^*) yielding r^*. Any investment beyond this point is inefficient, as the rate of return will be lower.

In developing countries, especially those which hold huge amounts of capital, the rate of return on capital can be ignored. A country might pursue some social and political objectives and continues to invest even if the rate of return on the last unit of capital is zero.

In practice, absorptive capacity has been measured indirectly. For example, Chenery and MacEwan (1966) point out that "The most convenient measure of this absorptive capacity limit is the rate of increase in investment which a country can achieve on a sustained basis". [5] They suggest that the most acceptable rate of growth in capital investment is between 15 and 20 per cent per year.[6]

Adler also argues that absorptive capacity depends on the time during which the determinant factors will adjust. He writes: "The more time is allowed to overcome the lack, or inadequate supply of the cooperant factors, the greater the absorptive capacity becomes". [7]

Although this method of measuring absorptive capacity depends on capital availability, it can only apply to a country which is not hindered by a

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[5] H. B. Chenery and A. MacEwan, Optional Patterns of Growth and Aid: The Case of Pakistan; Chapter 6, P. 151, in Irma Adelmen and Erik Thorbecke, ed.,The Theory and Design of Economic Development, The Johns Hopkins Press, Baltimore and London, 1966.

[6] H. B. Chenery and A. MacEwan (1966), op. cit. pp.151-152.

[7] J. H. Adler (1965) op. cit. p. 28.

savings-investment gap and an export-import gap. If a country experiences either gap it will invalidate the rate of return on invested capital as a measurement of absorptive capacity.

7.3 Limitations of Absorptive Capacity

The economic development process in LDCS is hampered by many factors that limit their absorptive capacity. Each country is faced with different limitations due to the differences in natural resource endownment. Each country has to deal with its economic constraints and increase the supply of cooperant factors in order to increase the absorptive capacity. Adler argues: "The only way to come to grips with the practical limitation of absorptive capacity is to devise specific measures to appraise specific limitations". [8] Adler also listed various limits on absorbtive capacity according to the broad classes of cooperent factors that could conceivably be in short supply.

7.3.1 Limited Knowledge

Developing countries are characterised by their lack of specific information regarding the natural resources they possess. Inadequate information about mineral resources, composition of soils, rainfall, river flows, are important factors that hamper most projects

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[8] J. H. Adler (1965), op. cit. p. 23.

in developing countries. In addition, data unavailability and lack of technical know-how are other factors of economic development constraint.

7.3.2 Scarcity of Enterpreneurs

One of the most obvious constraints to absorptive capacity in developing countries is the lack of an enterpreneurial class capable of undertaking the desired capital investment. The availability of capital investment opportunities alone is insufficient to carry out development projects without the presence of efficient management ready and able to execute economically such projects. The scarcity, if not the absence of such managerial talent in developing countries, could be considered as an obstacle for economic development.

7.3.3 Scarcity of Skills

The underlying problem of the lack of skilled labour in developing countries is one of the main constraints on absorptive capacity. Professional workers are the essential tools of design, execution, operation and maintenance of any investment projects. The absence of such tools or skills requires a dependence on foreign assistance which might not be desirable for political and financial reasons. Stolper,(1966), points out:

"Absorptive capacity is therefore ultimately limited by

the structures of the economy and the fact that investment decisions must be made over time. There are, of course, other limiting factors. Executive personnel are scarce and lose their effectiveness when overworked. Lack of executive capacity is a further limitation on absorptive capacity".[9]

7.3.4 Institutional Limitations

The political instability prevailing in developing countries could be regarded as one of the constraints to economic development and absorptive capacity. Weakness of the institutional structure of the society, for example, limits ability to maintain law and order which may discourage foreign investors from operating within the country. In addition, inadequate administrative procedures of developing governments might delay the execution of investment projects and in turn lower the rate of return on capital investment.

7.3.5 Cultural, Social and Political Limitations

Cultural and social values vary between developed and developing countries. Illiteracy, religious superstitions and tribal constraints have had negative influences on the discipline of factory life and have meant a reluctance to conform to rigid time schedules.

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[9] W. F. Stolper, Planning Without Facts, Lessons in Resource Allocation from Nigeria's Development, Harvard University Press, 1966, Chapter 3, p. 58.

Political instability in developing countries,on the other hand, is behind the so- called "brain-drain" syndrome. These factors collectively menace the whole process of economic development in developing countries. LDCS, therefore, should set in motion development programmes aimed at changing the attitudes of the labour force towards industrial life. In addition, serious efforts should be made to eradicate illiteracy and programmes for industrial training should be undertaken as measures to overcome some limits of absorptive capacity that exist in some developing countries.

7.4 Absorptive Capacity in Saudi Arabia (Analytical Framework)

The absorptive capacity in Saudi Arabia at any period of time can be defined as that level of gross domestic fixed capital formation which the country achieves during that period. In other words, Saudi Arabia's absorptive capacity can be measured by ascertaining the rate of increase in gross domestic investment that the country achieved on a sustained basis. This method of measurement, however, indicates that the maximum level of gross domestic investment in any one period cannot exceed the level of gross domestic investment in the preceding period multiplied by an exogenously determined rate of increase.

Applying Chenery and Macewen criteria entails that the Saudi economy is not constrained by either the saving- investment or export-import gaps. It is

necessary, therefore, to analyse the Saudi economy in the light of the Keynesian macro-economic model to point out whether or not the economy is hindered by those two gaps.

$$Y = C + I + G + X - M \qquad (1)$$

$$Y = C + Sp + T \qquad (2)$$

where

Y = gross domestic product
C = private consumption
G = Public consumption
X = Total exports of goods and services
M = Total imports of goods and services
Sp = Gross private savings
T = Total taxes
I = Gross Investment

Equation (1) expresses gross domestic product as an expenditure flow while equation (2) shows gross domestic product as an allocation of income.

From (1) and (2)

$$C + I + G + X - M = C + Sp + T \qquad (3)$$

According to the Keynesian definition of consumption, C in equation (1) is equal to C in equation (2).

Then

$$I + G + X - M = Sp + T \qquad (4)$$

$$I = Sp + (T - G) + (M - X) \qquad (5)$$

So long as aggregate total savings (s) are, by definition, equal to gross investment, equation (5) may be written as:

$$S = I = Sp + (T - G) + (M - X) \qquad (6)$$

Equation (6) indicates that the level of aggregate gross total savings is equal to the sum of aggregate private savings (Sp), aggregate public savings (T - G), and aggregate foreign savings (M - X). Subtracting foreign savings from both sides of equation (6) gives two measures of aggregate gross domestic savings (Sd).

$$Sd = I - (M - X) = Sp + (T - G) \qquad (7)$$

In order to avoid the common difficulties involved in estimating aggregate private savings and aggregate public savings, it is possible to calculate aggregate domestic savings indirectly by substracting aggregate foreign savings from estimates of gross investment. Thus, aggregate domestic savings can be estimated as follows:

$$Sd = I - (M - X) \qquad (8)$$

Equation (8) describes the case of most developing countries where domestic savings are below the investment level and the shortage will be provided by foreign sources called import surplus (M > X). In some developing countries where capital is not a constraint, the reverse case may occur where the import surplus is converted into an export surplus, i.e. (X > M).

In practice, however, the savings-investment and export-import gaps are the same, since the gap is in excess of the amount of resources used over the amount of resources produced by the economy. Re-arranging equation (8) yields the equality of the above two gaps in such a way that:-

$$I - Sd = M - X \qquad (9)$$

The economic situation of most developing countries can be expressed by I > Sd and M > X. In this case, the measurement of the absorptive capacity through the observed rate of increase in gross domestic investment is not applicable unless it can be shown that capital inflow exceeded the magnitude of the gap on a consistent basis.

On the basis of the above explanation, the case of Saudi Arabia will be examined. From 1967-1983, Saudi Arabia experienced a current account surplus except for 1968, 1969, 1978, 1982, 1983. [10] During the above

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[10] The current account deficit occurred in 1968, 1969, (Footnote continued)

period, the cumulative current account surplus was estimated at $160435 million. [11] Table (7.1) indicates that the bulk of this surplus occurred after the first oil crisis in 1973-74 as oil prices quadrupled. Despite these surpluses the Saudi economy was still unable to overcome some of the limitations on its absorptive capacity.

The cumulative current account surplus, however, is a savings-investment and export-import gap in reverse. Having established that the Saudi economy has not been constrained by either gap, it is possible now to measure its absorptive capacity by estimating the rate of increase in investment. Data on Saudi Arabia's real gross domestic fixed capital formation were used to measure the absorptive capacity, i.e. the rate of increase in capital formation in both the public and private sectors. In order to calculate the rate of growth of gross fixed capital formation, one has to consider the method and the time span. An annual average rate can be calculated by comparing the gross domestic fixed capital formation in 1983, for example, with the gross domestic fixed capital formation in 1975. Alternatively, it would be possible to calculate the rate of growth in every year and take the average (mean) as the representative rate of growth during the period in question.

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[10] (continued)
1978, 1982 and 1983. These deficits could be well accrued to a decrease in exports rather than increase of imports.

[11] International Monetary Fund, International Financial Statistics, Year Book 1985.

These methods, however, can be criticized on the ground that they involve only a comparison of two points in time and ignore economic development during intervening years. But they can still be sufficient in achieving their useful purpose .

TABLE (7.1)

SAUDI ARABIA BALANCE OF PAYMENTS (million dollars)

Year	Current Account Surplus (+) Deficit (-)	
1967	+	98
1968	-	92
1969	-	86
1970	+	71
1971	+	972
1972	+	2089
1973	+	2520
1974	+	23025
1975	+	14385
1976	+	14360
1977	+	11991
1978	-	2212
1979	+	11167
1980	+	41404
1981	+	38353
1982	-	1100
1983	-	18433
TOTAL	+	160435 US $

Source: International Monetary Fund, International Financial Statistics Year Book, 1985.

7.5 Gross Domestic Capital Formation in Saudi Arabia

Gross domestic capital formation rose rapidly during the period of economic planning in Saudi Arabia, especially during the second development plan. Great emphasis has continued to be placed on capital formation in both the private and public sector. Table (7.2) indicates that the total gross capital formation rose

more than six times from S.R. 2.7 billion in 1390/91(1970/1971) to S.R. 17.3 billion at the end of fifth year plan 1394/95(1974/75). Thus the rate of growth of gross capital formation was 59 per cent per annum compound on average.The oil sector, however, registered the highest rate of growth, 58.9 per cent compound on average, followed by the government sector with 57.6 per cent compound on average and private investment with 34.3 per cent compound on average.

TABLE (7.2)

GROSS CAPITAL FORMATION BY SECTOR (Million Riyals)

	1970/71 1390/91	1971/72 1391/92	1972/73 1392/93	1973/74 1393/94	1974/75 1394/95
Government	1,204	1,443	1,985	3,416	7,348
Non-Oil Private	1,151	1,290	1,669	2,351	3,859
Oil	577	670	2,040	2,633	3,659
TOTAL(GFCF)	2,932	3,403	5,694	8,400	14,866
Inventories	-205	95	-113	335	2,402
TOTAL(GCF)	2,727	3,498	5,581	8,735	17,268

Source: S.A.M.A., Annual Report, 1977, page 45.

Further analysis of gross fixed capital formation by type of capital goods indicates that the construction sector witnessed the highest rate of growth at the end of the first development plan. Table (7.3) shows that the rate of growth in the construction sector was 85 per cent followed by transport equipment 73.3 per cent and machinery and equipment by 42.8 per cent.

TABLE (7.3)

GROSS FIXED CAPITAL FORMATION BY TYPE OF CAPITAL GOODS

	1390/91	1391/92	1392/93	1393/94	1394/95
Construction	2,195	2,595	4,706	6,214	11,505
Transport Equipment	313	335	468	757	1,331
Machinery of Equipment	423	473	520	1,429	2,030
TOTAL (GFCF)	2,931	3,403	5,694	8,400	14,866

Source: Saudi Arabian Monetary Agency, Annual Report, 1397 (1977), page 46.

During the second development plan (1975-80) the growth of gross capital formation was higher than that obtained in the first plan. This could well be due to the fact that the first plan was issued while the economy was under financial constraints. In contrast the second plan was launched at a time when oil revenue had increased dramatically due to the oil price increase in 1973-74. Table (7.4) shows that capital formation increased rapidly in both the private and public sectors as government devoted between one-fifth and one-third of the national income to domestic investment. [12] At the end of the final fiscal year of the plan, total fixed capital formation increased from S.R. 17,268 million in 1394/95 (1974/75) to S.R. 94,977 million in 1399/1400 (1979/80) at a compound rate of 40.5 per cent on average. Expansion in expenditures for development purposes combined with the increase in the share of

12 Saudi Arabia Monetary Agency, Annual Report, 1401, (1981), p. 56.

capital goods in total imports during 1399/400 (1979/80) resulted in increased government capital formation to S.R. 61,598, i.e. an increase of 25.7 per cent over the previous year. Non-oil private capital formation increased by 19.6 per cent over the previous year. Capital formation in the oil sector also increased by 24.4 per cent to around S.R. 10,196 in 1399/400 (1979/80). Although the three sectors showed an increase in absolute amounts of capital formation, only the government sector increased its share in total capital formation from 64 per cent to 64.8 per cent.

The share of the non-oil private sector in capital formation declined from 25.3 per cent in 1398/99 (1978/79) to 24.4 per cent in 1399/400 (1979/80). The share of the oil sector remained almost constant at 10.7 per cent.

Looking at capital formation by type of investment, Table (7.5), indicates that the construction sector is still dominant. The amount of gross fixed investment in this sector increased to S.R. 76,864 million in 1399/400 (1979/80) after registering an increase of around 21 per cent over its level in the previous year.

TABLE (7.4)

GROSS FIXED INVESTMENT BY SECTOR (Million Riyals)

	1975/76 1395/96	1976/77 1396/97	1977/78 1397/95	1978/79 1398/99	1979/80 1399/1400
G. Sector	17,491	27,352	40,484	49,031	61,598
Non-Oil Private Sector	10,627	16,523	18,354	19,401	23,183
Oil Sector	5,422	7,316	8,053	8,222	10,196
T.G.F. Investment	33,540	51,191	66,891	76,654	94.977

Source: S.A.M.A, Annual Report, 1981, p. 58.

TABLE (7.5)

GROSS FIXED INVESTMENT BY TYPE OF CAPITAL GOODS

(Million Riyals)

	1975/76 1395/96	1976/77 1396/97	1977/78 1397/98	1978/79 1398/99	1979/80 1399/1400
Construction	26,889	37,684	51,542	63,412	76,864
Transport Equipment	3,539	5,491	6,371	6,756	6,911
Machinery of Equipment	2,798	7,546	7,773	5,926	10,685
Others	314	470	1,180	560	517
T.G.F. Investment	33,540	51,191	66,891	76,654	94,977

Source: S.A.M.A., Annual Report 1401 (1981) p. 58.

7.5.1 Gross Fixed Investment (Third Plan 1980-1985)

Total gross fixed investment at the end of the last fiscal year of the above plan declined by 2.4 per cent compound on average from S.R. 106,376 in 1400/01 (1980/81) to S.R. 46,646 in 1404/05 (1984/85). Table (7.6) indicates that the government sector alone witnessed this decline by 9.5 per cent compound on average, as gross fixed investment fell to S.R. 44,699 in 1404/05(1984/85) compared with S.R. 66,874 in 1400/01 (1980/81). Gross fixed investment in the non-oil private sector grew at a rate of 7.1 per cent compound on average. The oil sector witnessed a growth rate of 7.1 per cent compound on average as gross fixed investment increased from S.R. 10,811 in 1400/01 (1980/81) to S.R. 14.213 in 1404/05 (1984/85). The decline of investment in the government sector, however, could be well attributed to the fact that some development projects were completed while others required long periods of implementation. The share of the government sector in total gross fixed investment declined from 62.9 per cent in 1400/01 (1980/81) to 46.3 per cent in 1404/05 (1984/85). The share of non-oil private and oil sectors, in total gross fixed investment, on the other hand, increased from 27 and 10.1 per cent to 39.0 and 14.7 per cent respectively. The increase of investment in the private sector was due to the support and the incentives provided to the private sector by the government in order to play a leading role in the Kingdom's future economic development.

TABLE (7.6)

GROSS FIXED CAPITAL FORMATION BY SECTORS
(Million Riyals)

	1980/81 1400/01	1981/82 1401/02	1982/83 1402/03	1983/84 1403/04	1984/85 1404/05
G. Sector	66,874	73,881	66,411	53,325	44,699
N.O.P. Sector	28,691	35,830	34,162	41,107	37,734
Oil Sector	10,811	12,604	14,881	15,663	14,213
Total Gross Fixed Investment	106,376	122,315	115,454	110,095	96,646

Sources: (1) S.A.M.A. Annual Report, 1984, page 75.
(2) S.A.M.A. Annual Report 1986, page 82 and 83.

Table (7.7) indicates that during the third plan, total gross fixed investment by type of capital goods fell by 2.4 per cent compound on average. The reason could be well attributed to a reduction in the allocated investment expenditure of the government sector as a result of falling oil exports. Table (7.8) shows that investment in government sector during the third plan fell by 9.6 per cent compound on average. Table (7.9) also indicates that the value of oil exports fell by 75.9 per cent compound on average during the final three years of the third plan; 1402/03 (1982/83) - 1404/05 (1984/5).

TABLE (7.7)

GROSS FIXED CAPITAL FORMATION BY TYPE OF CAPITAL GOODS (Million Riyals)

	1980/81 1400/01	1981/82 1401/02	1982/83 1402/03	1983/84 1403/04	1984/85 1404/05
Construction	81,470	92,227	87,070	82,482	71,646
Transport & Equipment	7,449	7,988	8,599	9,063	8,153
Machinery	16,059	20,003	19,716	18,474	16,797
Others	1,398	2,097	69	76	50
Total FCF	106,376	122,315	-	-	-

Source: S.A.M.A., Annual Report, 1986, page 84-85.

TABLE (7.8)

EXPENDITURE ON GROSS DOMESTIC PRODUCT

In Purchaser's Value at Current Prices (Million Rivals)

Fiscal Years	1400/01	1401/02	1402/02	1402/04	1404/05
Government Consumption	81,915	128,526	126,854	121,803	115,869
Private Consumption	114,905	126,514	137,304	143,449	141.051
Gross Fixed Capital Formation	106,376	122,315	115,454	110,095	96,646
By Sector:					
Government	66,874	73,881	66,411	53,325	44,699
Non-Oil Private Sector	28,691	35,830	34,162	41,107	37,734
Oil Sector	10,811	12,604	14,881	15,663	14,213

By Type of Capital Goods:					
Construction	81,470	92,227	87,070	82,482	71,646
Transport & Equipment	7,449	7,988	8,599	9,063	8,153
Machinery	16,059	20,003	19,716	18,474	16,797
Other Capital Goods	1,398	2,097	69	76	50
Increase in Stock	6,427	-19,802	-2,559	3,334	7,743
Export of Goods and Services	368,425	354,919	219,445	168,420	133,995
Less Imports of Goods and Services	157,459	187,754	181,267	175,855	156,084
Expenditure on GDP	520,589	524,718	415,230	371,246	339,220

Source: SAMA, Annual Report, 1986, p.209.

TABLE (7.9)

SAUDI OIL EXPORT (Million Riyals)

	1982/83 1402/03	1983/84 1403/04	1984/85 1404/05
Crude	190,675	139,252	107,459
Refined of Which	14,228	13,199	10,692
Bunker Fuel	936	496	313
TOTAL	204,903	152,451	118,151

Source: S.A.M.A., Annual Report, 1986, page 65.

In general, increasing the rate of growth of gross fixed capital formation in Saudi Arabia during the 1970s and early 1980s, was an indicator of the increase in its absorptive capacity. The rate of growth of total investment over the period 1970-1985 was 26.8 per cent compound on average.

Having shown that the rate of growth of gross fixed capital formation increased rapidly in Saudi Arabia, one might wonder whether the increase was due to the increasing marginal efficiency of capital or due to an

increase in expenditure over the projected period during the implementation of the economic development plans. In addition, a comparison should be made between the rate of return on invested capital inside the country and the rate of return abroad. A discussion of this will follow.

Previous discussion has shown that the rates of return on domestically invested capital increased during the last period. Despite these increases, the domestic rate of return on capital is still below the rate of return on investment abroad. Saudi surplus fund as a form of foreign capital asset which has been estimated at $80 billion in 1980, is a self-explanatory factor. This form of capital investment, which involves risk, would not have been undertaken if domestic investment had yielded the same rate of return as investment abroad.

The reason for a low rate of return on domestic capital investment in Saudi Arabia could well be attributed to economic constraints which still exist in the non-oil sector in particular, and the whole economy in general. Lack of skilled labour, data unavailability on the composition of soil, an inadequate infra-structure, the cost of co-operant factors are all factors which contributed to the low rate of return on domestic investment in Saudi Arabia.

Planners in Saudi Arabia, however, have realised these problems and measures have been taken to reduce their effects in order to achieve favourable growth rates. Policy makers in Saudi Arabia have envisaged the

adoption of policies aimed at improving and modifying the educational and training programmes in order to replace the foreign skilled labour. The number of Saudi students studying abroad has increased, and the training of labour forces abroad has been carried out. Inflation, which rose during the implementation of second development plans was reduced in the last year of the second plan. [13] Public infrastructure (especially port facilities) was improved to handle the imported goods. In addition, the goals of the third plan turned to be selective in some areas such as utilising more efficiently domestic and foreign skilled manpower, increasing economic and administrative efficiency. Planners in the fourth plan emphasised a great concern about the operational efficiency in the use of resources and showed a determination to reduce the dependence on the production and export of crude oil as a main source of income by intensifying efforts towards the diversification of production and export base through increased emphasis on industry, agriculture and financial service. Consequently, the absorptive capacity of the economy was increased as is clear from the following sections.

7.6 Absorptive Capacity in Saudi Arabia (Empirical Framework)

The approach used for the estimation of domestic

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13 R. El.Malakh (1982), op. cit. p. 210.

absorptive capacity in this literature is one which investigates the amount of domestic investment which can be absorbed at an optimal social rate of return. Government expenditure, however, is an important factor in this approach, together with private and public investment. The limitation of absorptive capacity, on the other hand, tends to constrain investment in these sectors on the basis of economic evaluations. Absorptive capacity constraints, however, envisage the difficulties of empirical correlation between the variables that determine the absorptive capacity of the economy. Despite these difficulties, actual data about the economy has been used in order to estimate the absorptive capacity of Saudi Arabia through which the role of oil depletion can be examined and some policy implications can be allowed for. [14]

7.6.1 The Macroeconomic Model

(a) behavioural equations

$$Cp = a_0 + a_1 (NGDP + NGJ) + a_2 Cp_1 + U_1$$

$$CG = b_0 + b_1 OR + b_2 CG_1 + U_2$$

$$IP = C_0 + C_1 NGDP + C_2 DV + U_3$$

$$IG = d_0 + d_1 GEX + d_2 IG1 + U_4$$

$$M = h_0 + h_1 GDP + U_5$$

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[14] Data was obtained from Saudi Arabia Monetary Agency, Annual Reports, different issues. It was also obtained from International Monetary Fund, International Financial Statastistics, Year Book, 1985.

(b) Identities

DAC = CP + CG + IP + IG

GDP = DAC + TX - M

where

TX = E + X

(c) Endogenous Variables

Cp = private consumption

CG = Government consumption

IP = Private investment

IG = Government investment

M = total imports

DAC = domestic absorptive capacity

GDP = gross domestic product

(d) Exogenous Variables

NGDP = Non-oil GDP

GEX = government expenditure

OR = oil revenue

DV = dummy variables 0 for 1963-73 and 1 for other years

IGI = government investment lagged one year

TX = total exports

E = non-oil exports

X = oil export

U's = stochastic terms

7.6.2 Specification of Equations

Total consumption in the economy consists of the sum of private consumption CP and government consumption CG. Total capital formation in the Saudi economy, on the other hand, is equal to private investment IP plus government investment IG. Private consumption, however, is usually a function of disposable income, i.e. GNP minus tax from income. This definition, however, is irrelevant to the Saudi economy since more than half of GDP is originated from oil revenue. GNP, therefore, is not a good proxy of the purchasing power of the Saudis. In addition, income tax is almost non-existent and can be ignored. Thus, disposable income may be defined as non-oil GDP plus government injections.

$$Cp = a_0 + a_1 (NGDP + NGJ) + a_2 CP_1 \qquad (1)$$

The government's consumption is made to be determined by total oil revenue and government consumption lagged one year.

$$CG = b_0 + b_1 OR + b_2 CG_1 \qquad (2)$$

Private investment is very difficult to formulate as the interest rate is not officially permitted. Private investment, therefore, is determined by non-oil GDP and dummy variables to capture the change in private investment that occurred before and after the oil price

increases.

$$IP = C_0 + C_1 \text{ NGDP} + C_2 \text{ DV}(3)$$

Government investment is explained by government expenditure; and government investment lagged one year.

$$IG = d_0 + d_1 \text{ GEX} + d_2 \text{ IGI}(4)$$

Imports are simply made a function of gross domestic product. This, however, implies that the demand for import is derived from the domestic expenditure.

$$M = h_0 + h_1 \text{ GDP}(5)$$

7.6.3 Estimation Results:

Ordinary-least-squares will be used as a method of estimating the previous equations.

The result of the computer is stated as follows:

1. CP = -1.130 + 0.807 (NGDP + NGJ) + 0.868 CP1
   (-2.60)*** (2.56)*** (9.55)***
   R^2 = 0.965 $\bar{R}^2$ = 0.960 D.W = 2.4 D.h = -1.04
   F = 234.93

2. $CG = 0.765 + 0.311\ OR + 0.447\ CG1$

(1.60)* (2.40)** (2.33)**

$R^2 = 0.78$ $\bar{R}^2 = 0.75$ D.W = 1.55

D.h = 1.9178 F = 30.56

3. $IP = -0.636 + 0.788\ NGDP + 0.665\ DV$

(-1.84)** (10.02)*** (5.00)***

$R^2 = 0.976$ $\bar{R}^2 = 974$ D.W. 2.18 F= 359.76

4. $IG = 1.546 + 0.841\ GEX + 0.255\ IGI$

(-7.21)*** (8.57)*** (2.83)***

$R^2 = 0.991$ $\bar{R}^2 = 0.990$ D.W = 1.61

D.h = 0.9327 F = 1036.91

5. $M + -1.993 + 0.608$

(-4.91)*** (16.27)***

$R^2 = 0.929$ $\bar{R}^2 = 0.925$ D.W = 1.40

F = 239.92

* significant at 1% level

** significant at 5% level

*** significant at 1% level

Figures in parentheses are the t statistics

7.6.4 Testing of the Model

The T test has been used to test the significance of the regression coefficient. The results show that most of the regression coefficients are significant at a one per cent level and others at a five per cent level.

The F statistic has also been used to test the overall significance of the regression. In other words, it has been used to test the significance of the R^2 statistic. The F test with K - 1 and N - K degrees of freedom allow an explanation of the hypothesis that none of the explanatory variables helps to explain the variation of the dependent variable about its mean.

$$F_{K-1,N-K} = \frac{R^2/(K-1)}{(1-R^2)/(N-K)}$$

or

$$F_{K-1,N-K} = (R^2/(1-R^2)) * (N-K)/(K-1)$$

where

N = the sample size

R^2 = Coefficient of multiple determination or the goodness of fit

K - 1 and N - K = The degrees of freedom

K = number of explanatory variables including the

constant.

If the calculated value of F is greater than the tabulated value at, say a 5 per cent level, the null hypothesis is rejected. This means that R^2 is statistically significant and there is a linear relationship between dependent and independent variables and vice versa.

The results indicate that R^2 and R^{-2} are close in magnitude since there are a large number of degrees of freedom in the model. The results also show that the F test is highly significant.

In order to test for the absence of a serial correlation of the disturbance term, the Durbin-Watson Statistic has been used. Where there is a lagged dependent variable as explanatory variable, Durbin h test has been used.

$$h = \hat{P} \surd \{N / [(1-N)Var(\hat{B})]\}$$

where

$$\hat{P} = 1 - DW/2$$

N = Number of observations.

Var ($\hat{B}$)=The square of the standard error of the coefficient of the lagged endogenous variable.

DW =Durbin-Watson Statistic.

If h is less than the critical value of the normal distribution, there will be no autocorrelation.

The results of both tests indicated the absence of autocorrelation of the disturbance terms.

7.6.5 Structural Analysis of The Results

The important feature of the consumption function is that the short-term marginal propensity to consume has been increasing. In other words, 80 per cent of NGDP and NJG is spent on consumption goods which is an indicator of the increasing purchasing power of the private sector. [15] High short term marginal propensity to consume also reflects increasing trends in the absorptive capacity of Saudi Arabian economy. The government injections which emerged from the increasing oil revenue also reflects the influence of oil revenue in private consumption. Long term private consumption is also high (0.86) which expressed the fact that after 1973-74, the first oil increase, oil revenue increased dramatically. What this indicates for the Saudi economy is that relative to the population, government efforts to stimulate the effective demand has been significant.

The government consumption function shows that 31 per cent of oil revenue is spent on government consumption. It is indicative in the Saudi case to note that education, health, mass transport, water supply and other vital services are provided free of charge by the

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15 NGDP and NGJ are made to represent the disposable income.

government. The long term government marginal propensity to consume is 44 per cent. This could well be attributed to the fact that government consumption before the oil price increases was less than in the period that followed. This is also an indicator of the government dependency on oil sector.

The private investment function indicates that 78 per cent of non-oil GDP is spent on private investment. This is, however, a reflection of a high short-term level of private investment which the planners in the third and fourth plan were trying to increase and encourage. The strategy is that the private sector should become more involved in economic activities. This strategy is particularly welcome as a counter-attack on the enclave theory which argues that the oil sector is capital intensive and polarises the society into a modern and traditional sector, with high income and affluence in the modern sector and poverty in the traditional sector. If investment in the non-oil sectors gathers momentum as shown by the empirical work, this would indicate the growing participation of the private sector in the economic activities reducing more than before the growing gap between the oil sector and the traditional sector.

The government investment equation exhibits an increasing tendency towards investment with the coefficient of government expenditure being 80 per cent. The coefficient of the long term investment is relatively low; 0.25 per cent. This expresses the fact that when the economic development plans first started,

the economy was constrained by many factors, such as, the inadequate infrastructure. The government, therefore, was determined to remove this bottleneck by investing in ports, road, hospitals, etc., as a means of increasing the absorptive capacity in the economy. The government also noticed that the non-oil sector was dominated by agriculture, industry and other service sectors like transport, which were subsidized by the oil sector. The government's main concern is to increase the participation of other sectors in the activity of the economy by investing in these areas. The inclusion of industries here indicates the infant industry argument. Since these industries are newly established they cannot take full advantage of international economies of scale, hence the government subsidies this sector until it can stand such international competition. Also, the bulk of these industries form the petro-chemical sector, which in the case of fertilizer is vital to the government's policy of economic diversification, hence such a subsidy, we may argue, seems justified.

The result of the last equation shows that the marginal propensity to import, which is the ratio of the changing imports to the change in gross domestic product, is only 60 per cent. The result, however, is an indicator of increasing the absorptive capacity in Saudi Arabian economy.

The general conclusion that can be drawn from this analysis is that oil depletion and the revenue from oil have had a positive impact on the absorptive capacity and the performance of the Saudi economy as a whole.

The question that ought to be asked is to what extent the Saudi economy will depend on oil exports as a main source for revenue, bearing in mind that oil is an exhaustible resource?

Planners, however, have realised this danger and economic development plans were issued to counteract this problem by diversifying the economy and reducing the dependence on oil. It can be assumed, therefore, that planners, with the financial ability in mind, will be able to overcome the economic constraints in the near future. This, however, implies that the economy might become a semi-industrialised one with the assumption that all economic constraints will be removed. Policy-makers, however, will face another problem, namely that the market size is very small in Saudi Arabia. The Kingdom is one of the less populated nations and the small market size will bring about another problem. One of the useful methods that policymakers should adopt to overcome the problem, is the possibility of regional co-operation as a means of enlarging the market size and increasing the capital absorptive capacity in Saudi Arabia.

CHAPTER EIGHT

SUMMARY AND CONCLUDING REMARKS

The first conclusion that can be drawn from this thesis is the invaluable role that oil revenue has played in the process of economic development in Saudi Arabia. As explained earlier, Saudi Arabia was one of the poorest countries in the world before the discovery of oil. Since then, and particularly after the oil price increases in 1973-74 and 1979-80, oil revenue increased dramatically which enabled the kingdom to speed up the wheel of economic development by launching economic development plans together with encouraging the private sector to play its expected role in creating the modern Saudi Arabia. Had the oil not been discovered in the kingdom, it would have remained relatively poor as the revenue from pilgrimage would not have been sufficient to cover even the essential government expenditure. [1]

Also important was the role of oil depletion and its subsequent revenue in the Saudi absorbtive capacity. The empirical work shows that the ability of the economy to absorb some of the financial surplus of the oil revenue has increased somewhat due to the large investment scheme being put forward through the economic

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[1] Prior to the oil discovery and large commercial exploration and the resulting increase in revenues, Pilgrimage was the main source of Foreign Exchange; and today, it is still one of the contributors to exchange earnings.

development plans to increase the ability of each sector to play its part in the process of economic development.

Still, the fact remains that the market size in Saudi Arabia is relatively small. The kingdom is one of the least populated nations. Although oil depletion and its subsequent revenue played a significant role in increasing the absorptive capacity of the economy, the market size is still one of the main obstacles that planners would face in the future. One of the useful methods that policy makers should adopt to overcome this problem, is the possibility of regional cooperation or economic integration amongst Arab countries. Ignoring the political factor, this should be an easy task to achieve, bearing in mind that the kingdom would influence all Arab countries except Libya and South Yemen for example.

The reason behind this suggestion could well be found in economic literature mainly of those authors who wrote extensively about the benefits of economic integration. Also of importance was the benefit the European countries, for example, received from such a process.

It has been suggested that regional cooperation or economic integration is one of the methods of increasing absorptive capacity in developing countries. W.S. Stevens (1971) argues "Whatever the stage or degree of cooperation, the professed aim is to provide large outlets which will either directly increase the investment opportunities or to improve the return on old and projected capital formation through a better use of

the installed capacities and the achievement of scale benefits".[2]

In both East and West, developed countries have tended towards economic grouping with a view to confronting the problems they suffered from in the aftermath of World Wars I and II.

Arab countries, like the rest of the developing countries, are in fact more in need of economic integration than developed countries. It is the most favourable way to realise fast rates of growth and industrialization as integration means the assembling of their potential and the expansion of their markets.

In the case of developing countries, economic integration should be treated as an approach to economic development rather than a tariff issue. Accordingly, it combines various aspects which could improve the international trade position as well as raise the level of economic development of developing countries.

The dynamic effects of economic integration, however, consist of two separate and different arguments which are concerned with; (a) the effects of increased competition on exploitation of economic efficiency, and (b) large markets permitting the exploitation of economies of scale and the adoption of more up-to-date technology.

Once we consider the small size of domestic markets of individual Arab countries, the low average annual real growth rate of per capita income, and the growth

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[2] W.J. Steven, Capital Absorptive Capacity in Developing Countries (Leiden, Holland: A.W. Sijthoff, 1971, p.199.

rate of population, one would strongly argue that economic integration is badly needed as a vehicle to foster the development process in Saudi Arabia and the rest of the Arab countries. Not only that,but through integration, these countries could face the outside world with a stronger bargaining power.

As regard to the depletion policy of oil in Saudi Arabia, it is very hard to conclude without qualification whether oil is being depleted too slowly or too rapidly or at an optimum rate.

The oil market is full of imperfections and failures. With these imperfections in mind, the oil might be depleted too fast. It is not clear, however, to assume that market imperfections would lead to a non-optimal rate of depletion. What is true is that existence of environmental effects associated with the oil industry which are not reflected in the consumer prices, might increase the consumer demand and deplete the oil resource too rapidly. Other factors are also involved in the issue such as the excessive interest rate, and the problem of forecasting; as producers depend mainly on their own expectations which might lead to either too slow or too fast a rate of oil depletion.

Oil depletion policy in Saudi Arabia, however, was in the hands of oil companies during the 1950´s and 1960´s. This period could well be characterised by a rapid rate of oil depletion especially when we consider the low price level of crude oil at that time. Also of importance was the fact that the oil companies´ time-horizon was very short as they came to realise that

it was only a question of time until oil producers took control of prices and production policies in their territories. Thus, the oil in Saudi Arabia was depleted rapidly especially when compared with the corresponding low level of revenue received by the government. Also at that time depletion and conservation policies were hardly known to the government whose main targets were the financial requirements necessary for the Saudi economy. The depletion policy, therefore, seemed to be ignored.

When Saudi Arabia took control of the oil industry after the first oil crisis of 1973-74, the "limit to growth" and the conservation policy seemed to be well established. There was a strong argument that if the world went on depleting its resources at the current rate, a shortage of resources would appear and catastrophe would occur. However, the kingdom rate of production rose gradually until it reached 11 million barrels in 1980. This figure, with the prevailance of high price levels, covered not only the Saudis financial needs but also created a surplus which has been invested abroad. This brings into question the wisdom of optimum depletion policy as argued in the main thesis. The current need in respect to the level of development and absorptive capacity is estimated at 5 million barrels a day as against 8-11 million barrels that were produced during the 1970's. Such policies ignore the needs of future generations as it would be wiser to link production to depletion and development needs, bearing in mind that surpluses invested abroad would be subject

to downward fluctuations during periods of global inflation and currency devaluations.

The arguments put forward in support of the depletion theory is that future growth and developments in terms of technological invention and innovation would produce cheaper alternative sources of energy that would make the demand for oil more elastic and hence mean lower prices for the future. This argument is as mechanistic as it is unfounded because the special qualities possessed by oil can hardly be duplicated by other energy sources. Crude oil will still provide as an essential raw material for hydro-carbon based industries. Saudi Arabia could not by-pass success by keeping its oil in the ground and extracting it only to finance internal requirements.

The current policies confront each other on many fronts. The fact that current oil policy is allowed to be determined by considerations of immediate international politics conflicts with the Saudi government's acclaimed policy of preparing for future non-oil economy. On the other hand, investments in the petro-chemical plants in Saudi Arabia hardly coincides with the future needs of the country's inhabitants in the sense that the rate of current depletion could make the kingdom an oil importer for these industries which could involve huge foreign exchange transactions in the future.

In the light of the findings of this research, there is a need for the government to diversify its sources of revenue in order to reduce the current rate

of dependence on crude oil as the main source of foreign exchange revenue. Areas of potential sources of revenue previously ignored include income tax, custom duties and subsidies given to consumers of public utilities. All these could now be strongly investigated. The introduction of income tax, custom and excise duties and the gradual reduction of subsidies on public utilities to those who can afford it will enhance future revenue earnings.

Although the implementations of these policies would be an unprecedented change in economic management and could be considered by many as too radical, a realistic projection of future events would suggest no better and rational alternatives than those offered above. It depends very much, however, on how these policies are presented to the public. If presented as a package and gradually implemented they could face less hostility from the public when it is made known that the future 'survival Kit' for the kingdom rests on the above policies.

Generally, oil has increased the absorptive capacity of the Saudi Arabian economy and has had a positive impact on development. There is a need to supplement these roles with other sources of revenue and also the need to link depletion of oil to internal development needs in order to maximize income streams in the long-term. The failure to achieve this will form long-term structural adjustment problems for the kingdom's economy.

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