THE ROLE OF THE NON-OIL MINERALS SECTOR IN THE ECONOMIC GROWTH OF SAUDI ARABIA

by

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The candidate confirms that the work submitted is his own and that appropriate credit has been given where reference has been made to the work of others.

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Abstract

The macroeconomy of Saudi Arabia has been dominated by oil exports which between 1970 and 1995 accounted for more than 85% of total export earnings. Due to the fact that oil is an exhaustible resource, the price of which fluctuates considerably, and is produced in an enclave economy, the Saudi Arabian government had recognised the needs to diversify their economy away from oil as the main source of income. Since the oil price crashed in 1986, the Saudi Arabian government has adopted a new policy to develop non-oil sectors, such as manufacturing, agriculture and more recently, non-oil minerals. The main objective of this study is to evaluate the contribution of the non-oil minerals sector to the economic growth of Saudi Arabia during the period 1970-1995, using three different approaches. These approaches are the export portfolio approach, the input-output approach and the Dutch disease approach. The empirical findings of this study show the following:

1. A non-oil export portfolio analysis provided guidance to the Saudi Arabian planners who seek simultaneously to reduce export earnings instability and achieve economic growth. An increase in the volume of machinery and transport equipment commodities could produce an optimum portfolio due to both price trends and stability of price over time. Other exports, including non-oil mineral commodities, are unstable and have relatively negative price trends.

2. Even though preliminary results indicate that the non-oil minerals sector has a relatively low integration with other sectors, when the impact of inducing final demand is taken into account, this sector shows the highest income and the second highest employment multipliers. These results indicate that if this sector were to be stimulated by increasing final demand, it may well generate more income and employment than other sectors. Therefore, the application of an input-output approach was extended further to estimate the impact of three new promising non-oil mineral projects on the Saudi Arabian economy. Moreover, the construction and operation phase's multipliers reflect the potential of the non-oil minerals sector.

3.With regard to the effect of a boom in one sector of the economy on the rest of the sectors, the oil sector boom in the 1970s in the case of Saudi Arabia conforms very closely with the assumptions of the Dutch disease theory.

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List of Abbreviations

ARAMCO	Saudi Arabian Oil Company
Bpd	Barrels per day
DMMR	Deputy Ministry for Mineral Resources
EEC	European Economic Community
GCC	Gulf Co-operation Council
GSFMO	Grain Soils and Flour Mills Organisation
Km	Kilometre
Ma'aden	Saudi Arabian Mining Company
MPMR	Ministry of Petroleum and Mineral Resources
OPEC	Organisation of the Petroleum Exporting Countries
Petromin	General Petroleum and Minerals Organisation
PIF	Public Investment Fund
SAAB	Saudi Arabian Agricultural Bank
SABIC	Saudi Basic Industries Corporation
SAMA	Saudi Arabian Monetary Agency (Central Bank)
SDR	Special Drawing Rights
SGS	Saudi Geological Survey
SIDF	Saudi Industrial Development Fund
SPMAC	Supreme Petroleum & Mineral Affairs Council
Sq.	Square
SR	Saudi Riyal ($ 1 = SR 3.745, 1987-1995)

Chapter 1: Introduction

1.1 Background

Saudi Arabia is well known as one of the major oil exporting countries in the world. Thus, oil exports and oil revenues play a major role in the Saudi Arabian economy. Oil exports account for an average of 85% of its total exports, while government revenues from oil vary between 70 to 90% on average between 1970-1995. However, oil is a finite resource and reserves will eventually be exhausted. Moreover, fluctuation in oil prices mean the economy has faced a series of external shocks during the last two decades.

Throughout the Five-Year Development Plans (1970-1995), Saudi Arabian planners focused on economic diversification as a strategy to increase the production of the non-oil sector, such as manufacturing, agriculture and non-oil minerals, in order to reduce dependency on oil exports as a major source of government income and foreign exchange earnings.

Manpower shortage and limitation of absorptive capacity were the main problems for the industrialisation strategy facing Saudi Arabian planners. Accordingly, they have chosen a tightly focused formula for growth. They have elected to invest large amounts of capital and small amounts of manpower in a few key industries. Using its advantage of having plentiful capital, a bounteous supply of energy and feedstock, Saudi Arabia has concentrated on two heavy process industries: basic metals and petrochemicals. However, recent years have also shown an increasing

number of light industries as a result of government encouragement for an import substitution strategy.

1.2 Importance of the Study

In its commitment to diversify the economic base away from the oil sector, the Saudi Arabian government started to re-evaluate its policy with respect to diversification. In response to the fall of oil prices in 1982-83, Saudi Arabia realised the need to establish new industries that increase the role of the non-oil sector in the economy. The non-oil sectors, such as manufacturing and agriculture, were developed mainly through subsidies and the provision of incentives for private investment. Despite these efforts, the non-oil role in the economic growth is still relatively low, and its shares in both Gross Domestic Product (GDP) and exports are small. This failure of diversification could be attributed mainly to three reasons.

(1) The oil sector has a weak linkage to the rest of the economy. Unlike other industries which draw their inputs of land, labour and capital from a wide variety of other smaller industries and, in turn, stimulate and invoke a wide range of productive activities, oil offers few such backward and forward linkages.

(2) The oil industries' market is characterised by uncertainty (instability). Given Saudi Arabia's heavy dependence on oil and the fluctuation of oil prices, the ability of the government to stabilise the total earnings is uncertain. Uncertainty about the availability of government revenues is

thought to complicate further the already difficult task of development planning. Moreover, uncertainty is taken to affect private investment.

(3) Symptoms of the 'Dutch Disease' are present in the Saudi Arabian economy. It is believed that the oil boom was an obstacle to economic diversification in Saudi Arabia. The Dutch disease has induced structural changes on the Saudi Arabian economy. The oil boom induced structural changes through government spending effect that induced an appreciation in the real exchange rate following the acceleration of spending on the non-tradable sector e.g., goods and services. The excess demand for tradable goods induced by the boom is satisfied by imports at constant world price while the excess demand for the non-tradable goods will be offset by both their relative prices and their production. This implies an expansion in the non-tradable sector and a contraction in the tradable sector such as manufacturing and agriculture.

However, the government's new trend was to develop and promote the non-oil minerals (mining and quarrying) sector in order to enhance its weak role in the Saudi Arabian economy. In fact, the government is providing substantial incentives to develop the sector. The reasons behind the new Saudi Arabian policy can be summarised as follows. Firstly, large reserves of both metallic and non-metallic minerals such as gold, iron, copper and clay have been found. Secondly, it is believed that the non-oil minerals industry has relatively strong linkages with other sectors inside the country. Finally, non-oil mineral exports, as well as other

non-oil commodities, could help in reducing the instability in exports and, in turn, reduce Saudi Arabia's total revenues fluctuation.

1.3 Aim and Objectives of the Study

The aim of the study is therefore to test whether or not the new Saudi policy in developing the non-oil sector could successfully diversify the economy away from oil. The study, in particular, will evaluate the role of the non-oil minerals sector in the economic growth of Saudi Arabia during the period 1970-1995. Specifically, the study was intended to meet the following objectives:

1. To highlight the main characteristics of the Saudi non-oil minerals sector.

2. To evaluate and assess the Saudi diversification plans seeking to increase non-oil export earnings and reduce their instability.

3. To examine and assess the linkages between the non-oil minerals sector and the other sectors of the economy, as well as the multiplier effects (output, income, employment, exports and import multipliers) of the sector on the rest of the sectors.

4. To estimate the economic impacts of the new, promising, non-oil mineral projects.

5. To investigate the effects of a boom in the oil sector on the non-oil sector in the economy and on the non-oil mineral sector in particular.

1.4 Hypotheses of the Study

Four hypotheses are put forward, and these will be tested in the study.

1. Non-oil exports diversification is expected to reduce the Saudi earnings' instability and increase its growth. This hypothesis will be tested in Chapter 5.

2. The inter-industry linkages of the non-oil mineral sector with the rest of the economy are predicted to be relatively strong, and its multiplier impacts especially, the income and employment multipliers, are expected to be strong as well. These hypotheses will be tested in Chapter 6.

3. The economic effects of the new non-oil mineral promising projects are expected to be strong. This hypothesis will be tested in Chapter 7.

4. The booms in the oil sector are expected to result in an increase in relative prices of non-tradables to tradables, which would result in an expansion in the non-traded goods sector and contraction in that of traded goods. This hypothesis will be tested in Chapter 8.

1.5 Methodology of the Study

In order to test the hypotheses stated above, three main approaches are adopted.

1. Portfolio Approach

This approach is used in Chapter 5 in order to give guidance to Saudi planners who seek, simultaneously, to increase non-oil export earnings and reduce their instability. The objective of the export portfolio approach is to reduce fluctuations in total Saudi Arabian earnings below the level experienced by the individual commodities. Specifically, the purpose of the approach is to investigate operational guides to export diversification strategies to achieve greater stability in export earnings.

2. Input-Output Approach

This approach is adopted in Chapter 6 in order to estimate and evaluate both the inter-industry linkages between the non-oil minerals sector and the other sectors of the economy, and the effects of a unit increase in the final demand of non-oil minerals on total output, income, employment, total exports and total imports (the multiplier effects). The aim of doing this is to see the extent to which the non-oil minerals sector is integrated with the rest of the sectors of the economy. The input-output approach is also applied in Chapter 7 in order to estimate the multiplier effects of some new mining projects.

3. Dutch Disease Approach

This approach is used in Chapter 8 to estimate the effects of a boom in the oil sector on relative prices of non-tradables to tradables, on the one hand, and on the structural composition of output in both sectors, on the other. The purpose of doing this is to investigate whether a boom in the Saudi oil sector leads to the results predicted by the Dutch disease theory or not, and how Saudi planners could respond to combat its symptoms in the tradables sector and in non-oil minerals in particular.

In other chapters of the study, we use the descriptive approach to investigate the Saudi development strategy and highlight the main features and historical developments of the Saudi economy and non-oil minerals sector.

1.6 Outline of the Study

The study is divided into nine chapters, the first of which is this introduction. The other chapters are organised as follows:

Chapter 2 characterises the features of the Saudi Arabian economy. Three phases of economic development are highlighted during the period under consideration (1970-1995). This chapter provides an extensive description of Saudi economic background, to give a broad idea of the Saudi economic structure.

Chapter 3 begins with a critical survey of the main arguments for the policy of industrialisation. An overview of a variety of industrialisation theories and strategies is presented. The Saudi industrialisation policy is examined and discussed to see whether it complies with any of these strategies. Both oil and non-oil industries are introduced in order to see to what extent the Saudi industrialisation strategy succeeded in diversifying the economy away from crude oil as the main source of income.

Chapter 4 touches upon the background of the Saudi non-oil minerals resources' sector. It highlights the existence of mining industries, and their characteristics in terms of reserves, productions, exports and imports. It also discusses the effects of the non-oil minerals sector on the Saudi economy by examining its direct contribution to the different macroeconomic components, such as GDP, balance of payments, employment, and foreign exchange savings. Furthermore, an analysis is made to pinpoint the main incentives introduced by the government to promote the sector.

Chapter 5 sheds light on the terms of trade between developing and less developed countries, and the variability in short-term commodity prices, in terms

of the causes and domestic consequences of export instability. The portfolio approach to export diversification, as proposed by Markowitz, is presented. The objective for applying the portfolio approach is to provide guidance to Saudi planners who seek simultaneously to increase non-oil export earnings and reduce their instability.

Chapter 6 covers the input-output approach applied in order to estimate the inter-industry linkages between the non-oil minerals and other economy sectors in Saudi Arabia. One of the main aims of this chapter is to estimate the multiplier effects of the non-oil minerals sector on the Saudi economy, i.e., the estimation of its outputs, exports, imports, income, and employment multipliers.

Chapter 7 shows how the input-output approach is applied again, given the result of the previous chapter, to trace the special incidence of impacts on the micro level to complement the macro picture. Bearing in mind the new promising non-oil mineral projects, it is possible to show the effects of an expansion within the non-oil mineral sector resulting from changes in the final demand for that sector's products. The aim is to draw on the economic impacts of each and the whole of the major extensions in the non-oil minerals industry employing an input-output approach.

Chapter 8 investigates the change in exchange rate, the stunting of growth of manufacture (de-industrialisation), unemployment, the national income and real

GDP. The chapter focuses on how to combat the impact of the Dutch disease on the Saudi economy.

Chapter 9 is a summary of the study findings, and provides some recommendations for promoting and diversifying the Saudi economy and developing the non-oil minerals sector, and suggestion for further research.

Chapter 2: Saudi Arabian Economic Development

2.1 Introduction

This chapter is devoted to providing a brief overview of the Saudi Arabian development process, as an aid to understanding of the Saudi economy as a whole. Furthermore, examination of the economic policy would help in pointing out the limitations and the problems facing Saudi Arabia when it implements its economic policy.

2.2 Saudi Arabian Development Strategy

Saudi Arabia is roughly two-thirds the size of India or one-quarter that of the USA, with a relatively small population of 20 million in 2000. Before the discovery of oil in the Arabian Peninsula, it would be difficult to speak of a unified entity such as the Saudi Arabian economy. Before the 1930s, the region that would later come under the control of the Saudi state was composed of several regions that lived off specific resources and differentiated human activities. The Western Province (the Hijaz), for example, depended mainly on subsistence agriculture, some long-distance trade, and the provision of services to pilgrims travelling to the holy cities of Mecca and Medina. A plantation economy that grew dates and other cash crops dominated the Eastern Province (Looney, 1982).

In the early stages of Saudi Arabia (1930-1945), the only non-traditional economic opportunities for Saudi citizens were linked to employment in the

military, provision of services for pilgrims, and some modest contracts and commissions. The little revenue was adequate to allow only minimal government functions, not to undertake economic and social projects. After the end of World War II, the development of the country's oil resources resulted in some wage payments to Saudis and local purchases of goods and services by foreign oil companies, but the impact on the Saudi economy was initially minor. Until 1970, oil income increased slowly, and the government usually operated under financial constraints. The government's economic decisions were largely those of determining priorities among alternative uses of limited resources (Findlay, 1994).

The quantum jump in oil revenues in 1973-74 allowed the country to be the widespread agent of economic change, replacing the traditional economy with one that depended primarily on the state's outlays. The government has raised the average Saudi citizen's standard of living to one of the highest levels in the world, and established for most of its residents world class infrastructure and social services. But sustaining real income growth still depended primarily on government expenditure, which was largely facilitated by oil revenues. Therefore, the government could not afford to neglect the oil sector, the primary engine of economic growth. Despite attempts to diversify the economy, developing a self-perpetuating non-oil sector has proved more difficult than earlier Saudi planners had predicted (Vassiliev, 1998).

2.3 Development of Saudi Economic Policy

Saudi Arabia first established a planning agency in 1958 in response to suggestions of International Monetary Fund (IMF) advisers. Planning was limited in the 1960s, partly because of Saudi financial limitations. The government concentrated its limited funds on developing human resources, the transportation system, and other infrastructure aspects. In 1965, planning was formalised in the Central Planning Organisation, and in the 1975 government re-organisation, it became the Ministry of Planning. The Ministry of Finance and National Economy controlled funding and had considerable influence over the execution of the plan.

Although the economic policies were formalised and adopted through each Five-Year Plan, three major events have reformed the Saudi economic policies. During the period studied (1970-1995), Saudi Arabia has experienced three phases of economic and political events. The first phase (1970-1985) was known as the oil boom period. This phase experienced an expansion in the industrial sector, construction, infrastructure and transport, and several pipeline projects grew rapidly to facilitate the sale of oil. The second phase (1986-1989) started after the crash of oil prices in 1986. The sharp downturns in world oil prices led to a decline in oil revenues and the draw-down of foreign investments to supplement the domestic expenditures. The third phase (1990-1995) was in the 1990s, specifically during and after the Gulf War in 1990-1991. The Gulf War had a harmful effect on the economy by forcing the government to borrow from international institutions. These three events have had an impact on the Saudi economic structure, and hence, on the Saudi policy makers' strategies. In the

remaining part of this chapter we are going to introduce and analyse these policies and the main economic characteristics for each period separately.

2.3.1 Economic Policy During the Oil Boom (1970-1985)

In the early 1970s, the economic situation changed dramatically. The quantity of oil exports expanded substantially, royalty payments and taxes on foreign oil companies increased sharply, and oil-exporting countries, including Saudi Arabia, began setting and raising oil export prices. Saudi revenues per barrel of oil, averaged from total production and oil revenues, increased from US$0.22 in 1948 to US$1.8 in 1970. By 1973, the price had reached US$5.04, and higher in 1974 following the Arab oil embargo. In 1982, the average export price per barrel of oil reached well above US$29. As a result, between 1973 and 1980, Saudi oil revenues jumped from Saudi Arabian Riyal (SR) 13.4 billion to SR 189.3 billion. At last, the higher oil revenues gave the Saudi government the means to make major structural changes in the economy.

One choice facing Saudi planners in the early 1970s was whether to control oil production at a level that was adequate to finance limited economic and social development, or to allow production at a level that would meet world demand for crude oil. Choosing a relatively high production level would force a decision on whether to use resulting revenues for rapid domestic economic and social development or long-term investments abroad. Those planners who wanted to restrict oil production, except for that needed for limited development, argued

strongly that this policy would best preserve the country's resources for future generations.

The choices emerged by 1974, and Saudi Arabia pledged to keep oil flowing at moderate prices, appropriate to world needs, arguing that the country was as dependent on the stability and prosperity of consuming countries as those countries were on Saudi oil. Saudi Arabia advocated a policy of moderate increases in oil prices that, in effect, would index the oil price to world inflation, and to economic growth in the major consumer countries (Rustow, 1983). Moreover, if Saudi Arabia wanted to ensure that oil would remain the energy source of choice, moderate prices were crucial.

Despite these attempts to moderate oil prices, the supply and demand basics of the international oil market combined with the changes in ownership of downstream assets to raise international oil prices, creating huge pressures on the domestic front to invest rising oil revenues in developing the country's economic and social infrastructure.

By the mid-1970s, the government had decided to use most of the growing oil revenues for a massive development effort. An important part of that effort was to industrialise, largely by investing in processing plants that used the country's vast hydrocarbon resources. Such strategy was laid down in the Council of Ministers'

Statement of National Industrial policy in 1974[1]. This strategy meant at least a decade of very large investments to build the plants and the necessary infrastructure. It meant financing and building the gas-gathering system, the pipelines for gas and crude oil to bring the raw material to the two chosen main industrial sites, Al-Jubail and Yanbu, and building the industrial sites themselves. According to Turner and Bedore (1979), Saudi Arabia allocated SR 56.2 billion for hydrocarbon-based industries. The development effort also included many other projects, such as huge airports, hospitals, schools, industrial and plants, roads and ports. As illustrated in Table 2.4 (page 29), between 1970 and 1985, the massive government expenditures totalled more than SR 2 trillion.

A large part of the funds spent on development programmes were intended to promote private sector investment and to support future objective. The private sector was encouraged to "take the initiative, and mobilise its own resources" (Fourth Development Plan, p. 42). This encouragement took the form of tax concessions, trade protection and the provision of cheap finance and industrial sites. This government funding was estimated at nearly 50% of the capital invested by the private sector between 1974 and 1979, and about SR 11 billion during the Third Development Plan (1980-1985) alone (Soufi and Mayer, 1991). Furthermore, government expenditure was directed to more productive sectors in order to meet its future objective, the diversification. The emphasis was on import substitution instead of trade and construction only. The government increased the

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[1] Statement of National Industrial Policy in Saudi Arabia (Council of Minister's Resolution No. 15 dated 2.6.1974).

funding to manufacturing industry, and built the industrial complexes at Al-Jubail and Yanbu.

Starting in the mid-1970s, the government decided that an adequate infrastructure was crucial to future development. Providing this infrastructure included refurbishing and building electricity, water, sewerage, desalination, and telecommunication systems. Moreover, it entailed creating airports and ports, and laying a vast network of roads. In terms of generating and distributing electric power, the government assisted private companies in building and operating its electricity network through concessionary capital loans and continuing operating subsidies. Apart from upgrading distribution facilities for water, the government built several desalination plants, and drilled wells, built dams, and installed pumps. Telecommunications were quickly brought to international standards, allowing Saudi Arabia to handle all its communication needs in local and international telephone, telegraph, maritime, and television distribution services, via cable, satellite, and terrestrial transmission systems. In the period 1973-1985, there was a massive increase in government spending on education, to an annual level of about 10% of the budget.

The main problem in the period of rapid development of the mid-1970s to the early 1980s stemmed from the government's interest to subsidise production, consumption, and investment. The objectives of subsidies were threefold: encouraging non-oil economic activity, meeting social goals, and redistributing income. The subsidy programme may have created greater problems than were

earlier anticipated. Saudi planners never thought that oil revenues would constrain spending to the extent that they did in the late 1980s and early 1990s. Most Saudi production subsidies had been indirect subsidies, which reduced the cost to consumers of electricity and other industrial inputs, leading to unnecessary waste. The industrial sector thereby became a relatively inefficient producer and made little effort to wean itself from government assistance. For example, the slump in oil revenues in 1982-83 forced the Saudi government to reconsider its subsidies to the industrial and agriculture sectors. As a result, the number of industrial licences issued in the first half of 1983 fell sharply by 50% compared to those issued in 1982 (Vassiliev, 1998).

The pace of modernisation was also economically disruptive. The substantial development effort created many risks, especially in the structure of the Saudi labour market and in high inflation. The Saudi labour force has undergone tremendous change in the latter decades as a consequence of the modern economy. The size of the effort and the technology involved required the contribution of a huge number of foreign workers for a long period, with the potential of disrupting the society. With the domestic labour force growing at an average of 5% annually between 1975 and 1985, despite an annual population growth among the highest in the world at 3.5%, foreign labour was still necessary. According to the Ministry of Planning, the total work force in 1980 was around 3 million, of which 0.8 million workers were in producing sectors and 2.3 million were in the services sectors. As shown in Table 2.1, labour was concentrated in four main sectors in 1980. Agriculture accounted for 17.8% of the total work

force, construction 20.9%, commerce 10.6%, and social services, including government service, 34.4%. By 1995, the total labour force had risen to close to 7 million, with 1.06 million in production sectors and 5.9 million in service sectors. Agriculture's share had fallen to 5.5%, construction was down to 15.3%, whereas commerce's share of the labour force rose to 14.8%, and community and social services were up to 48.6%.

Table 2.1: Development of Labour Force in Saudi Arabia by Sectors (1970-1995)

(In thousands)

Sector	Year					
	1970	1975	1980	1985	1990	1995
Agriculture	445.8	426.1	545.6	538	393.2	377.2
Oil	20.2	21.3	36.0	65.1	53.6	60.4
Non-Oil Mineral	25.7	45.6	47.0	62.9	52.3	59.1
Manufacturing	36.1	46.5	170.4	424.1	494.7	566.9
Utilities	12.2	18.3	67.0	112.2	66.5	79.7
Construction	141.5	314.2	638.9	1470	916.7	1060.7
Commerce	130.2	211.0	323.1	688.7	921.9	1026.7
Transportation	62.1	103.2	180.0	316.5	274.9	319.9
Service	250.2	357.2	654.6	1163.1	2218	2549.8
Government	112.7	168.8	399.4	469.1	711.2	817.7
Total	1236.7	1712.2	3062	5309.7	6103	6918.1

Source: Ministry of Planning (1999).

The domestic work force numbered 1 million people (58% of total employment) in 1975. By 1980, employment of foreigners had risen from 723 thousand in 1975 to more than 1 million (or 46% of total employment). They were about 57% of the labour force in 1992, and about 90% of the labour force in the private sector in 1995 (Sixth Development Plan, 1996-2000). There is no official figure on the Saudi unemployment; however, according to a new non-official estimate, Saudi unemployment has risen from 13.4% in 1992 to 20% in 2000 (Saudi American Bank, 2001). These figure led the Saudi government to implement a new policy

called 'Saudisation', in order to replace foreign workers by domestic workers. The Saudisation plan involved equality in the application of the labour regulations between Saudi and non-Saudi workers, and an increase in the number of technical and vocational education institutions. Some observers questioned whether Saudi refineries and petrochemical plants would be efficiently managed and prove competitive within a reasonable time. According to Johany et al. (1986), Saudi Arabia found itself in a position to build both its capital stock and its labour force and, at the same time, produce a balanced industrial development. As the Saudisation plan was implemented recently in the last Five Year plan, the outcome of this policy may take years to succeed.

By the mid-1970s, the country had also encountered high inflation. As a result of massive expenditure, as well as supply difficulties linked to the incomplete infrastructure, a strong inflationary pressure was experienced in Saudi Arabia. Another reason was the heavy reliance on imports to meet the excess demand.

Table 2.2: Inflation in Average Rates (%)

Five-Year Development Plans				
First (1970-1975)	Second (1976-1980)	Third (1981-1985)	Fourth (1986-1990)	Fifth (1991-1995)
16.29	9.5	-0.14	-0.16	2.12

Source: SAMA Annual Report (1998).

As illustrated in Table 2.2, the first and second development plans (specifically, the period 1973-77) experienced the highest rates of inflation. Since 1978, the rate of inflation has been significantly reduced as a result of the government's

adopting many fiscal and monetary measures, such as reducing government expenditure, appreciation of the Saudi currency, which had a positive effect on import prices, and control of the money supply. Thus, compared to the annual average rise of 16.3% in the general cost of living index during 1970-1975, the rate of inflation in Saudi Arabia during 1978-1985 averaged only 0.8% per year.

Table 2.3 below, shows the growth rates of GDP during the first phase (1970-1985), in Saudi Arabia. GDP for the first Five-Year Development Plan (1970-1975) was to increase by 9.8% per year (in constant prices) and show the greatest increase in the non-oil sectors. The unanticipated great expansion of crude oil production, accompanied by large increases in revenues per barrel, contributed to an exceptionally high rate of economic growth, of 10.2%, while non-oil real GDP increased far beyond the Saudi planners' expectations by 11.1% per year in the same period.

In the second Development Plan (1976-80), GDP was to grow at an average rate of 10% per year. The non-oil sector's real planned rate of increase was 13.3% per year; the oil sector's projected rate of growth was 9.7%, although actual growth would depend on world markets. Despite the massive increase in government expenditures, overall real GDP growth at an average of 8.3% per year was below the planned 10% rate. This lower growth resulted from a slower than anticipated growth in oil production, a function of international market conditions factors. Non-oil GDP grew at an average annual rate of 11.6% per year compared with a planned rate of 13.3%. The producing components grew at 16.6% per year on

average (the real plan rate was 13%), with most components outpacing their targets. The following components all exceeded their targets: agriculture, manufacturing, utilities, and services (including commerce, transport, and finance). Construction paralleled the planned growth rate, and non-oil mineral and public sector projects did not meet targets.

Table 2.3: Gross Domestic Products by Oil and Non-Oil Sectors

(Constant 1970 Prices, million SR)

Five-Year Development Plans	Year	Oil Sector			Non-Oil Sector			Total Annual Rate of Growth (%)
		GDP Value	Annual Rate of Growth (%)	Share in GDP (%)	GDP Value	Annual Rate of Growth (%)	Share in GDP (%)	
First	1970	11277	-	56.7	8630	-	43.4	-
	1971	13731	17.87	59.8	9232	6.52	40.2	13.3
	1972	16934	18.91	61.6	10561	12.58	38.4	16.5
	1973	19575	13.49	61.9	12067	12.48	38.1	13.1
	1974	18639	-5.02	58.8	13085	7.78	41.3	0.3
	1975	18869	1.22	54.8	15593	16.08	45.3	7.9
Second	1976	20375	7.39	51.4	19294	19.18	48.6	13.1
	1977	21241	4.08	50.5	20787	7.18	49.5	5.6
	1978	21801	2.57	48.6	23037	9.77	51.4	6.3
	1979	23401	6.84	47.4	25970	11.29	52.6	9.2
	1980	24232	3.43	45.5	29050	10.60	54.5	7.3
Third	1981	21949	-10.40	40.5	32214	9.82	59.5	1.6
	1982	13787	-59.20	28.5	34555	6.77	71.5	-12.0
	1983	12443	-10.80	25.8	35844	3.60	74.2	-0.1
	1984	11451	-8.66	24.3	35766	-0.22	75.8	-2.3
	1985	9785	-17.03	21.6	35519	-0.70	78.4	-4.2
Fourth	1986	13641	28.27	28.5	34183	-3.91	71.5	5.3
	1987	12769	-6.83	27.1	34396	0.62	72.9	-1.4
	1988	14345	10.99	28.3	36388	5.47	71.7	7.0
	1989	14950	4.05	29.4	35875	-1.43	70.6	0.2
	1990	18094	17.38	32.2	38149	5.96	67.8	9.6
Fifth	1991	22876	20.90	37.5	38086	-0.17	62.5	7.7
	1992	24495	6.61	39.1	38168	0.21	60.9	2.7
	1993	23564	-3.95	37.9	38700	1.37	62.2	-0.6
	1994	23606	0.18	37.7	38978	0.71	62.3	0.5
	1995	23619	0.06	37.6	39258	0.71	62.4	0.5
Average			1.69	41.3		5.69	58.7	4.3

Source: GDP values taken from SAMA Annual Report (1998).

The third Development Plan (1981-1985) coincided with the sharp downturn in Saudi oil production. The oil sector's output fell on average 21.2% per year. As a result, during the five years of the plan, the average annual real GDP growth rate declined by 3.4% compared with a planned annual increase of 1.3%. The principal factors behind the continued positive rates of growth in the non-oil sector (3.9% on average per year) were the relatively few cutbacks in government expenditures and the continuation of major infrastructure and industrial projects despite declining oil revenues. The non-oil manufacturing sector and utilities expanded at 12.4% and 18.6%, respectively, but at annual growth rates well below their targets. The construction sector contracted, but only at half the rate of what was expected. The agricultural sector grew rapidly, surging to 8.1% per year. The service sector maintained its momentum during the third plan, with commerce and government services leading the way. Transportation and finance, however, fell well below their targets.

2.3.2 Economic Policy After the 1986 Oil-Price Crash

The general thrust of Saudi economic strategy underwent a fundamental change after the oil price crash of 1986. The serious exhaustion of foreign assets, combined with the extensive decline in oil revenues, imposed a revised economic policy. The depreciation of the United States dollar on international financial markets also harmed Saudi purchasing power abroad. Saudi external terms of trade deteriorated rapidly, because oil exports were largely denominated in United States dollars, and the bulk of Saudi imports came from countries whose

currencies were appreciating relative to the US dollar, such as Western Europe and Japan.

Reassessment of the development programme became necessary. The priority task was shoring-up government finances, yet domestic constraints allowed only a few options, especially in terms of raising non-oil revenues. Imposing an income tax, for example, was out of the question, partly because of its political dangers in a country where it was an unknown procedure likely to raise questions of income distribution and taxation without representation. Also, an income tax seemed impractical because the bureaucratic difficulties involved in collection would be more expensive than the tax revenue would justify. The government held back some current account spending and cut capital spending, partly by delaying projects and also by cancelling some programmes. Moreover, it was informed by the government, that subsidies of private sector vast capital expenditures had ended for the present and, whereas certain major projects would be completed, the government's emphasis would shift to improving the efficiency and maintenance of its public assets.

The government's attempts to deal with the persistent budget deficits, largely through expenditure reduction, depletion of foreign assets, and the sale of development bonds, generally helped stabilise its financial situation by the late 1980s. It became clear by 1989 that the economy had weathered some of the other problems, such as the spate of bankruptcies of private companies, the growth of bad banking debts, and the massive outflow of private capital to overseas financial

centres that followed the oil-price crash of 1986. During 1989 and 1990, economic planners had renewed optimism. New plans were made to put the oil and non-oil sectors of the economy on a surer footing. The perceived recovery in international oil consumption and prices provided the government with the opportunity to resume spending to promote economic growth. As a result, two major initiatives became the basis of Saudi economic policy.

Firstly, Saudi Arabia unveiled plans to raise crude oil production capacity to between 10.5 million and 11 million barrels per day (bpd) (Findlay, 1994). With the restructuring of the General Petroleum and Mineral Organisation (Petromin), formed in 1962; the creation of Samarec[2], which was given control over most of the Saudi oil refineries; and the announcement of a major plan to upgrade domestic and export refineries, a comprehensive picture emerged of the government's effort to promote oil investments. Another indication of Saudi intentions came in 1989, when the national oil company Saudi Arabian Oil Company (Saudi Aramco) purchased 50% of Star Enterprises in the United States, a joint venture with Texaco, that signalled Saudi pursuit of geographically diversified downstream projects.

Secondly, the government was not willing to continue its expansionist fiscal policies, Askari and Dastmaltschi (1990). Despite moderately higher oil prices,

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[2] Samarec was acquired completely by Saudi Aramco in 1996.

defence expenditure, oil capacity expansion plans, and current expenditures accounted for the bulk of total spending, and did not permit a fiscal boost. However, because the non-oil private sector remained largely dependent on government expenditures, the sharp reductions in capital expenditures constrained economic diversification. In the light of this failure, the government adopted two strategies to reorient and promote the private sector.

Given the fall in oil revenues, the government funding agencies were unable to continue to provide enough sources to the private sector. The government recognised that existence of strong financial institutions can play a major role and channel the surplus private sector capital into development projects. As a result, reform of the financial sector was the government's main option. Since 1988, the Saudi Arabian Monetary Agency (SAMA), created in 1952 to serve as the central bank, had made great steps in boosting commercial bank balance sheets through mergers, debt write-offs, and injection of funds to prevent failures. Subsequently, banking regulations and supervision were tightened, and compliance with international capital adequacy requirements enforced. SAMA also encouraged banks to take a more active role in financing private sector investments (Presley, 1989).

Protectionism as a government policy was also introduced during this period (1985-1989). Partly motivated by the impasse in Gulf Co-operation Council (GCC) negotiations with the European Communities (EC), but mainly to protect domestic private investment, Saudi Arabia began enforcing some restrictive tariff

and other barriers that had been instituted in the mid-1980s. Conforming to GCC-wide levels, it raised its tariff rates to 20% on most items, with certain industrial items gaining protection at higher rates. The government also began enforcing other regulations, such as preference for nationally-produced commodities and the continued application of preference for local contractors, as well as quality standards that favoured local production. In addition, it assiduously protected domestic banks from foreign competition by barring the sale of any foreign financial products and services.

During the period of fourth Development Plan (1986-1990), oil revenues plummeted following the oil-price crash of 1986. Overall real rates of GDP growth averaged a positive 10.8% per year. The revival in crude oil output from the low levels of 1986, however, boosted oil sector growth rates to 4.1% per year. The sharp decline in external income caused lower rates of output expansion in the producing sectors. Construction and non-oil mineral sector growth rates fell by 8.5 and 1.9%, respectively. Other manufacturing continued to grow modestly at 1.1% per year, but well below the 15.5% target. Commerce, transport, and finance reflected the financial setbacks in the government's programme with annual average production declines. Two surprises helped to offset the depressed growth rates: agriculture, which had shown steadily higher rates of output growth in the second and third plans, rose by 13.4% per year on average during the fourth plan, and nearly doubled its planned rate; and the utilities sector's ability to surpass its planned target of 5% per year (see Table 2.3).

2.3.3 Economic Policy After 1990

The Gulf War halted the 'mini-boom' that the above policies had fostered. In the immediate wake of the Iraqi invasion of Kuwait in 1990, the government faced two tasks. Firstly, it had to deal with the massive outflow of assets from the domestic banking sector by liquidating the commercial banks (which lost more than 12% of their deposits within the first month of the crisis), encouraging a repatriation of private assets, and restoring the confidence of foreign creditors who had cancelled lines of credit as a precautionary measure. SAMA reversed most of the haemorrhage caused by the loss of confidence in the Saudi riyal. Secondly, the government was obliged to raise oil output to levels unseen since the early 1980s. Saudi Aramco had to respond to a serious crisis without an adequate consideration of its overall production capacity. It quickly became apparent that the country had sufficient capacity to replace the bulk of the 4.5 million to 5 million bpd of Iraqi and Kuwaiti oil embargoed by the United Nations (UN). Production increased rapidly to 8.5 million bpd, which restored some calm to the international oil market; however, by the end of 1990, oil prices were nearly double those in June 1990.

Supporting the allied multinational forces, however, placed a massive burden on the government's budget. The deficits for 1990/1991 reached record levels, so the fiscal authorities were forced again to engage in further external asset draw-downs, increased volumes of development bond sales, and for the first time, external borrowing from commercial banks and export credit agencies. Saudi

Arabia was a prominent member of the World Bank[3]. However, because of the country's high per capita income, it was not entitled to borrow from that organisation. Most of the major projects programmed before August 1990, however, were preserved. Moreover, external borrowing had gained credence as the means to fund not only budgetary deficits but also the capital programmes of major public enterprises. Notably, Saudi Aramco did not scale back its crude oil capacity expansion plan. Rather, it appeared that new ways of financing were being sought from foreign commercial banks, multinational companies, and the domestic private sector. Saudi Basic Industries Corporation (SABIC) also moved to raise capital overseas, while Saudi Consolidated Electric Company (Sceco), the electricity company, requested foreign suppliers to help finance its expansion programme.

The fiscal crisis did not cause economic problems for the private sector because the government's reduction of its budgeted spending was relatively small, as seen in Table 2.4. Domestic government spending in support of the Gulf War effort surged, and many Saudi companies benefited from Gulf War-related contracts. Also, as a result of the Gulf War, the more than 600,000 troops of the multinational forces increased domestic spending on consumer goods. The mini-boom, which was interrupted by the Iraqi invasion, was revived by this increase in government expenditures, and then received further stimulus by three other factors.

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[3] Saudi aid to IMF during the period 1976-1980 constituted 6% of the country's GDP (World Bank,1980, World Development Report).

Table 2.4: Annual Saudi Budgets (Billion SR)

Year	Revenue							Expenditure	Total Budget + Surplus and - Deficit
	Oil	% Share	Annual % Growth Rate	Non-Oil	% Share	Annual % Growth Rate	Total		
1970	5.1	90		0.5	9.7		5.7	6.1	-0.4
1971	6.8	86	17.1	1.1	14.2	5.8	8.0	6.3	1.7
1972	9.8	88	29.7	1.3	11.9	1.9	11.1	8.1	3.0
1973	13.5	88	36.6	1.9	12.2	5.5	15.3	10.2	5.1
1974	39.3	94	258.3	2.4	5.8	5.5	41.7	18.6	23.1
1975	49.2	89	99.1	5.9	10.7	34.9	55.1	35.0	20.1
1976	93.5	90	442.9	9.9	9.6	39.9	103.4	81.8	21.6
1977	121.2	89	277.1	14.8	10.9	48.6	136.0	128.3	7.7
1978	114.0	87	-71.5	16.6	12.7	18.5	130.7	138.1	-7.4
1979	115.1	88	10.4	16.4	12.5	-1.9	131.5	148.0	-16.5
1980	189.3	90	742.2	21.9	10.4	54.7	211.2	188.4	22.8
1981	319.3	92	1300.1	28.8	8.3	69.1	348.1	236.6	111.5
1982	328.6	89	92.9	39.4	10.7	106.0	368.0	284.7	83.3
1983	186.0	76	-1426	60.2	24.4	207.6	246.2	243.8	2.4
1984	145.1	70	-408.8	61.3	29.7	11.2	206.4	222.3	-15.9
1985	121.3	71	-237.8	50.2	29.3	-111.4	171.5	212.9	-41.4
1986	42.5	56	-788.8	34.0	44.5	-161.3	76.5	260.0	-183.5
1987	67.4	65	249.4	36.4	35.1	23.7	103.8	200.0	-96.2
1988	48.4	57	-190.1	36.2	42.8	-2.1	84.6	159.6	-75.0
1989	75.9	66	275.0	38.7	33.8	25.0	114.6	141.2	-26.6
1990/91[1]	118.1	76	-	36.6	23.6	-	154.7	140.5	14.3
1992	127.0	77	-	38.4	23.2	-	165.4	359.6	-194.2
1993	106.0	75	-210.3	35.5	25.1	-28.7	141.5	181.0	-39.5
1994	95.5	74	-105.4	33.5	26	-19.6	129.0	197.0	-68.0
1995	105.7	72	102.4	40.8	27.9	72.6	146.5	160.0	-13.5

[1]Due to Gulf War, Budget Allocation for the fiscal year 1990 was amalgamated with the budget for 1991.
Source: SAMA (1997).

First, the private sector again repatriated capital, and the stock market boomed, with share issues rising to unprecedented levels. Secondly, changing regional politics encouraged many firms which had set up manufacturing and processing plants for the domestic market, to seek sales in Iran, Turkey, and Central Asia. Thirdly, the government cut domestic fees and utility charges almost in half. This

increased subsidy was targeted to both lower and middle income Saudis, but had the net effect of raising domestic disposable income.

As constrained resources shaped the fifth Development Plan (1991-1995), overall GDP growth rate was 2.2% per year below the target plan of 3.2%. Oil sector output was increased by 4.8% per year (nearly double the expected increase of 2.2%), while non-oil sector growth rate was increased only by 0.6%, below the target of 3.6%. Agriculture, other manufacturing, utilities, and finance were to pace the economy, while other sectors would show only modest growth rates of 2% to 4% year.

2.4 Conclusion

Saudi Arabia, like most of the developing countries, is a mono-economy. Crude oil is the main source of the country's foreign exchange. While oil revenues, since 1970, replaced the old Saudi economy with a new economy, they made the country vulnerable to oil price fluctuations. We have seen in this chapter that during phase one of Saudi Arabian economic development, the authorities tried to consolidate the massive inflow of oil revenues to build the infrastructure and raise the living standard of Saudi citizens. In the second phase, however, these plans were interrupted by the negative consequences of the massive decline in oil prices. The authorities embarked on a series of political and economic reforms in order to improve the domestic economic conditions. The results of these reforms were impressive. In the third phase, however, the Gulf War again slowed down Saudi economic growth.

This chapter has presented a general overview of the Saudi Arabian economic development strategy. Saudi industrialisation policies will be analysed in the following chapter. Both oil and non-oil sectors industry will be examined in order to assess the Saudi diversification strategy away from crude oil as the main source of Saudi income.

Chapter 3: Industrialisation, Theory and Practice: Saudi Arabia, 1970-1995

3.1 Introduction

As mentioned in the previous chapter, Saudi Arabia's heavy reliance on crude oil exports as a main source of income and exchange earnings resulted in a series of external shocks during the past twenty-five years. The decline in oil prices on 1986 caused the country to experience a severe reduction of foreign exchange in which infrastructure development and production depended. As a result, the growth rate of the economy slowed. Since then, the Saudi planners changed their development policy by concentrating investment on non-oil sectors such as manufacturing, agriculture and, more recently, non-oil minerals to diversify the Saudi economic base and reduce dependency on crude oil as a major source of income.

This chapter discusses the issue of industrialisation in developing countries, and in Saudi Arabia in particular. We begin with a critical survey of the main literature on the arguments for deliberate industrialisation, and then examine the industrialisation experience of Saudi Arabia between 1970 and 1995.

3.2 Deliberate Industrialisation in Developing Countries

Industrialisation has often been seen as a panacea for the problems of developing countries. A common justification for a deliberate industrialisation programme as the most promising solution for economic difficulties of developing countries is related to the question of transmission of development through trade. The question

arises of how the industrialisation programme can best be implemented. This question has been tackled from a wide range of angles, and the result has been a variety of theories, including import substituting industrialisation (ISI), 'big-push', balanced growth versus unbalanced growth, etc.

The selection of ISI as a development strategy starts when the government accepts the idea that development can be initiated by import replacement. In addition to the above arguments for deliberate industrialisation, ISI is also advocated because of the LDCs' desire for political independence and their recurring balance of payments difficulties. The best sign that ISI is an intended policy is the growing pattern of tariff protection and other incentives given to different industries over time.

The functioning of ISI has been easier than export expansion for governments, since the only action needed is to impose tariff and quantitative restrictions on imports. These restrictions on imports have various impacts, as perceived by Maitra (1967) and Van (1964) who had studied these impacts on East Africa. First, they set up obvious investment opportunities in the protected industries with extra profits as a result of protective measures. Investible resources were then directed into protected new industries (leading to structural change), thus increasing the capitalist sector. Assuming that capitalists are higher savers and reinvest their profits in the already expanded industrial activities, it was then expected that the process would lead to an increase in both the saving rate and investment. Secondly, foreign exchange realised by reduced imports of consumer

goods could be utilised in importation of raw materials and investment goods to expand further the process of the industrialisation. Thirdly, foreign manufacturers might be forced into setting up local plants through fear of losing the local market through import restrictions. A high profits share and hence a higher saving ratio in the protected sectors would lead to low demand for imports. As a result, the foreign exchange difficulties could be overcome, and more labour and natural resources could be utilised in productive industries. Moreover, in the long run, improvements in skill (learning by doing) and other favourable externalities from industrialisation could spread technical progress and investment to the export sectors.

In general, ISI was perceived as a strategy of self-generating phases, in the sense that new industries come into existence as the domestic markets for goods are being shaped (Hirschman, 1968). It begins with consumer goods, and then extends into more sophisticated goods, and then gradually into investment and capital goods. The reason that ISI begins with consumer goods is firstly due to the existence of a large market primarily for consumer goods, while the market for capital and investment goods is limited because of the very small manufacturing sectors, so its expansion depends on previous investment programmes. Secondly, the cost disadvantage between domestically produced and imported goods is lower for consumer goods than for investment and capital goods; the initial capital expenditure for consumer goods is much lower than for the latter; also, they require much lower levels of technological sophistication. However, many economists have disagreed with the principle of the ISI model perceived by

Hirschman. They have found that, in practice, the transition from consumer to investment and capital goods is difficult and even virtually impossible to achieve in most LDCs (see, for example, Felix, 1968). Bruton (1970) also argued that consumer goods are inessential to the development process, and an increase in their cost and their prices is less harmful than an increase in the price of capital and investment goods which are perceived to be more vital for the development process.

To promote ISI strategy, therefore, the imports of capital goods are also favoured against their domestic production by lower tariff rates and exchange rates that significantly understate their real costs to society. In other words, protective tariffs which are the main factor of the ISI strategy are usually biased against consumer goods and in favour of capital goods. High protection is given to final consumer goods, while capital goods, intermediate and raw material inputs receive less or no protection. To intensify ISI policy, other means are often used in conjunction with tariffs, import controls, and overvaluation of exchange rates. These means range from the provision of cheap loans by developments banks to direct government participation in the preferred industries. In short, ISI policy is expected to operate as the engine of growth, development, and social transformation.

However, it is now fully recognised that ISI policy is not a panacea for the problems of the LDCs, and that it can not be relied upon to overcome these problems on its own and bring about the expected growth and development. In the neoclassical framework, maximum world welfare in terms of production is

attained if countries produce and trade according to their comparative advantage. According to the Heckscher-Ohlin theory of international trade, a country can promote a higher economic growth if it specialises in producing that good which uses the country's abundant factor of production. In other words, a country tends to have lower comparative cost in the commodity that uses the largest amount of the relatively cheapest factor in its economy. These considerations provide the fundamental rationale for specialisation. In this framework, ISI, by distorting the market through the imposing of tariffs and other protective systems, and by deviating from the principle of comparative advantage, leads to misallocation of resource and inefficiency, and is thus doomed to failure. Economists such as Krueger (1984) have rejected this theory because it is based on the assumption of a perfect competitive international market. They contend that, in reality, the international market is distorted. They also argue that history shows that not all LDCs have followed this theory, such as Korea, Mexico and Malaysia. If they did, they would have specialised in producing primary goods, while developed countries would have specialised in manufacturing goods. However, specialisation in producing primary goods might not be beneficial for LDCs because of the declining terms of trade for these goods, and price instability. As the assumptions of the neoclassical framework do not hold in reality, especially in the case of LDCs, then its absolute rejection of the ISI policy is not valid. This, however, does not mean that one can abandon the criterion of comparative advantage and efficiency altogether.

Other economists have also criticised the ISI policy. For example, Little et al. (1970) argue that excessive protection encourages over-development of ISI and contravenes the principle of comparative advantage, and gives rise to distortions in the domestic factor and production markets, in the sense that labour in manufacturing industries, and domestic currency in terms of foreign currencies are overvalued, while capital is undervalued. They argue in favour of promotion rather than protection of industries, i.e. subsidisation of labour cost, education, training, etc. These economists are concerned with development policy which promotes those industries which are potentially capable of using factors of production efficiently. They suggest that strategies for allocation of resources have to be carried out in such a way that it would eliminate the divergence between market and social costs and benefits.

The Rosenstein-Rodan (1966) 'big-push' theory emphasises the need for external economies to be realised through industrialisation, and advocates a high minimum amount of investment in order to jump over the economic hindrances to development. The fundamental idea of a big-push, as perceived by authors such as Nurske (1964), was as a measure for conquering the cruel circle of poverty, i.e. a country is poor because savings are low, hence investment is low, hence there is no growth, and hence poverty continues.

The 'big-push' approach has been included into a demand-side version of 'balanced growth' theory. This version is based on indivisibilities in the production function and demand-side considerations. It states that in a developing

economy, the demand for a particular manufactured good is insufficient to support the minimum of output of an efficient manufacturing factory and, if it gets under way by itself, it is likely to fail, since its beneficiaries (owners and workers) will want to spend their earnings not only on the products of their factory but on a variety of other goods. As a result, this factory will not be established, and the only way to make development possible is to establish simultaneously a range of different new industries.

Hirschman (1958) has three basic criticisms of the balanced growth theory. First, he argues that, from the demand point of view, balanced growth is only required in special situations; if the new industry is either cost-reducing rather than output increasing (or even output-increasing if its output is highly desired) or import replacing or export-oriented, it would be established separately from schemes for balanced growth. Second, he points out that although this balanced growth is rationally very satisfactory, it is extremely expensive in terms of scarce resources and independent decision-making. He added that the country's obtainable resources, especially in capital, entrepreneurs and decision-makers, at any one time, set some limits on the number of synchronised investments that can be made simultaneously. Thirdly, he argues that if LDCs had sufficient technical and enterpreneurial resources for the simultaneous setting-up of a large number of industries, they would not have remained underdeveloped any more.

Instead of arguing for a broad front of investments, the advocates of 'unbalanced growth' theory stress that the task of a development strategy is to look after

disproportion and disequilibria. The economy is assumed to be 'squeezable', and it responds to the right kinds and doses of stimulus. The question they try to answer is this: Given a limited amount of investment resources, and a series of proposed projects whose total investment exceeds the available resources, how do we select the projects that will make the greatest contribution to development?

According to Hirschman, the relative desirability of the growth of various economic activities may be analysed through considerations of the structural independence between any activity and all the others. He specifies two inducement mechanisms through which one activity gives stimulus directly and indirectly to the others: the backward linkage effects and the forward linkage effects. He argues that the most useful industrialisation policy would be to encourage those industries (sectors) with potentially higher combined linkages, because this will provide the maximum inducement to other sectors to develop.

The notion of inter-industry linkages has attracted great interest, and has been used by several economists in the formulation of development strategy. Rostow (1956) in his 'take-off' theory, for example, adopts this approach, and goes on to say that successful industrialisation is unbalanced, in the sense that a single or limited number of activities are the source from which an initial acceleration ramifies through the economy. In his clarification, such activities have three channels of effect upon the economy: forward, lateral (which attempts to bring technology into the analysis), and backward linkages, of which the latter has conquered historically. Furthermore, he argues that the capital goods' industry is a

major stimulator of impacts, and its presence in the economy is a good index of the extent of industrialisation and probability of its extension.

However, the linkage-based or growth-inducing mechanism as a development policy has been criticised. Firstly, there is argument as to whether countries which have had a better record of growth have emphasised the unbalanced route and high linkage sectors (Yotopoulos and Nugent, 1973). Secondly, it is also argued that, because of import leakages, it cannot be taken for granted that high potential linkages will be realised (Panchamukhi, 1975). Thirdly, it is suggested that output multipliers alone can barely provide the necessary information that the planners need for choosing the priority sectors in a situation of multiplicity of objectives. For example, industries with high backward linkages usually tend to have low employment and factor income linkages, and hence it is argued that the pursuit of linkage-based development policy leads to a conflict between employment and growth objectives (Mandeville and Jensen, 1978). Fourthly, this development policy is also criticised for its lack of consideration of final demand pressures, income distribution efficiency, comparative advantage, etc. (see for example, Burdekin; 1978, Riedel, 1976). There are also some criticisms regarding the method of measurement of linkages. We have devoted Chapter 6 to a comprehensive theoretical and empirical assessment of these arguments.

3.3 Structural Features of the Saudi Economy

In this section, we examine in detail the structural characteristics of the Saudi economy, the economic instability associated with exporting crude oil, and the industrialisation policies which aimed at increasing production of the non-oil

sectors. To have a better understanding of the characteristics of the Saudi economy structure, we concentrate our investigation in this chapter on the role of the oil sector and its impact on the Saudi economy. We will then provide insights into the non-oil sectors, particularly the industrial and agricultural sectors.

3.4 Role of the Oil Sector in the Saudi Economy

Saudi Arabia is the world's most important oil producer. Given its relatively high production levels, accounting for nearly 13% of world output and 35% of total output of the Organisation of the Petroleum Exporting Countries (OPEC) in 1991, and more significantly, its small domestic needs, the Saudi dominance of international crude oil markets is unchallenged. Although reluctant to play the role, Saudi has become the 'swing producer', balancing international oil demand and supply. Therefore, within limits, Saudi oil production strategies can have a profound impact on international prices. Since the early 1970s, Saudi Arabia has occasionally used this dominance to influence oil prices, usually to further its objectives of sustaining long-term oil consumption and ensuring economic stability in both the developed and developing countries.

The oil sector is the key domestic production sector. For instance, oil revenues constituted 74% of total budgetary revenues in 1994. Export oil revenues accruing to Saudi Aramco, a large portion of which is allocated to the budget, accounted for 90% of total exports in 1991. Expenditures on oil sector development, however, are estimated as 10% of total budgetary spending annually (Michalski, 1997).

3.4.1 Crude Oil Production and Pricing Policy

Saudi oil policies, in terms of production and pricing, will also be important for the rest of the world, given the importance of Saudi oil as a major capital exporter. Saudi Arabia in fact has the capacity to provide 5% of the world's demand for oil products. According to Quandt (1981), Saudi Arabia's primary means for advancing its national interests is its oil production. Thus, decisions on production levels, prices, and investment in future capacity take on extraordinary importance. The Saudi oil policy was based on three objectives: (1) sustaining moderate international oil prices to ensure the long- term use of crude oil as a major energy source, (2) developing sufficient excess capacity to stabilise oil markets in the short term, and maintain the importance of Saudi Arabia and its permanence to the industrial countries as a crucial source of oil in the long term, and (3) obtaining minimum oil revenues to further the development of the economy. Although these Saudi oil production policies were, and may still be criticised by some OPEC members, it is justified by the fact that Saudi Arabia has the largest reserves of oil in the world. According to economists such as Quandt (1981) and Rustow (1983), Saudi moderation on prices, compared with other OPEC members, may have led to some short-term losses, but could be justified by longer-term preferences for discouraging the development of alternative energies on a scale that might replace Saudi production, and by a general interest in a stable international economic order and a strong dollar.

Despite the fact that the Saudi role was crucial in engineering the price leap of 1973-74, the Saudis have made no secret of their preference for small and orderly price increases. Saudi behaviour in the oil market since then reflected its attempts to ensure both objectives. In the early 1980s, oil prices increased rapidly because of the breakdown of the old, vertically integrated system of multinational oil companies, following nationalisations by producer governments during the 1970s. Other causes of the price rises were the disruption of Iranian exports during and after the Iranian Revolution in 1979, and the destruction of the Iranian and Iraqi oil sectors during the Iran-Iraq War of 1980-88, which worsened an already low level of spare production capacity. High oil prices in the early 1980s stimulated the rapid growth of non-OPEC oil supplies such as in Siberia, the North Sea, and Alaska (Looney, 1990).

The increase in supply accompanied by the fall in world demand, resulted by a global recession, caused oil prices to decline sharply in late 1982, forcing OPEC to establish a voluntary output reduction system by assigning individual quotas. The new scheme failed to stem the price drop, however. By 1985, spot oil prices had fallen to about US$25 per barrel, from an average of US$32 per barrel in the early 1980s.

Saudi adherence to an official price system, which most OPEC members discarded, rendered the Saudi the swing producer. As a result, Saudi was forced to cut back production to ever lower levels. In 1979 and 1980, Saudi Arabia had

peaked at an output of more than 10 million bpd; by 1986, that amount had reached a low point of 3 million bpd (Masood, 1989).

In early 1986, Saudi Arabia ended selling its oil at official prices and switched to a market-based pricing system called "netback pricing" that guaranteed purchasers a certain refining margin. In doing so, Saudi Arabia recaptured a significant market share from the rest of OPEC. The sharp increase in oil supplies precipitated the crash of spot prices from an average of US$28 per barrel in 1985 to US$14 per barrel in 1986. Saudi Arabia had used its 'oil weapon', significant excess capacity combined with adequate foreign financial reserves cushioning the blow of lower oil revenues, to establish some discipline in OPEC (Soufi and Mayer, 1991).

It did not take long before OPEC agreed to a new range of quotas tied to a price target of US$18 per barrel. By late 1986 and early 1987, prices rose to US$15 or US$16 per barrel for the OPEC basket, from well below US$10 per barrel in early 1986. To avoid a swing producer role, Saudi Arabia imposed an important condition on other OPEC members: a guaranteed quota of approximately 25% of the total output ceiling, correlated to a US$18 per barrel price objective.

The latter became the centre of controversy within the organisation for much of the period before the Iraqi invasion of Kuwait. A revival in oil demand growth rates in the developed countries between 1988 and 1990, partly aided by several years of low oil prices and double digit annual consumption growth in the newly

industrialising countries of East Asia, gave OPEC the chance to induce price increases above US$18 per barrel. Some members called for OPEC's overall output ceiling to be expanded by a smaller factor than the growth in anticipated demand, which would in effect push oil prices up, possibly back to their early 1980s' level. Whereas Saudi Arabia, however, has always endeavoured to maintain moderate oil prices, regional political and economic concerns have also motivated it not to depress prices too far, the 1986 Saudi-induced price crash notwithstanding.

The Gulf War allowed Saudi Arabia to regain its status within OPEC. At each successive OPEC meeting until the gathering of ministers in February 1992, Saudi Arabia dictated the final agreements with virtually no opposition. The eleven active members were producing at capacity, while prices remained relatively high. Between March and July 1991, both Iran and Saudi Arabia expertly sequenced the unloading of large stocks of oil in 'floating storage', which had been built up as insurance during the Gulf War, and prevented an anticipated crash in oil prices during the spring and summer months of 1991 (Findlay, 1994).

In 1992, the OPEC agreement reached was essentially what the Saudis wanted in the short run: a total production ceiling of almost 23 million bpd, and a temporary quota of 35% of the ceiling and the maintenance of price stability. They did not achieve their long-term objective: unanimous OPEC recognition of a 35% market share of all future OPEC output ceilings.

Short-term oil policy in the early 1990s was shaped by two major sequences of events. The first was the Saudi refusal to play the role of 'swing producer' in the mid-1980s, their subsequent attempt to maintain their market share, and desertion of the fixed oil price system after the 1986 price crash. The second was the Gulf War in 1990, the Saudi replacement of most of the oil lost from its two OPEC members, and the country's ascendance as unchallenged leader within OPEC after August 1990. Both set of events prompted formation of an oil policy that called for OPEC decisions to promote moderate and stable oil prices, but not compromise the Saudi demand for its market share. Before the Gulf War, the Saudis demanded about 25% of the OPEC production ceiling; after the Iraqi invasion of Kuwait, the share rose to 35% (Zind, 1998).

Longer-term Saudi policy imperatives for the 1990s were shaped by structural factors within OPEC and within the international oil market. Highest on the priority list was the decision to push domestic oil capacity to more than 10 million bpd sustainable capacity, with a further 1.5 million to 2 million bpd surge capacity in times of emergency. Three factors motivated these expansion plans. First, growth in world demand for oil over the previous several years, combined with the Gulf War, had pushed Saudi Arabia and other OPEC countries to their production capacities. With the expectation that demand for oil would continue to grow, and that most other exporters were constrained by depleting oil reserves or financing problems, a rapid rise in capacity could capture any increase in demand that might occur. Secondly, in light of the post- 1986 intra-OPEC market share competition, oil capacity expansions had a direct impact on the ability of

individual members to jockey for quota increases. Finally, the ability to increase output at will, in the event of a sudden price decline, would help to reduce instability of total oil revenues, which constituted the bulk of domestic budgetary income.

Saudi Arabia's interest in moving downstream was also a priority of its oil policy. The drive to obtain overseas refining and storage facilities was designed to advance two objectives related to security of supply. First, Saudi Arabia wanted to obtain captive buyers of its crude, assuring stable prices and terms. Saudi Arabia would thus be more receptive to market conditions in consuming countries and avoid being closed out of certain countries. Gaining further profits from refining the crude was an associated reason for the move downstream overseas. Second, the Saudis sought to provide consuming countries with 'reciprocal security measures', under which they would undertake to guarantee supply through capacity additions or stocking arrangements abroad in return for consumer country decisions to avoid taxes and import restrictions on oil. Few consuming countries, however, responded favourably to such arrangements. Those that did included South Korea and the Philippines, Askari et al. (1997).

It is clear from the above argument that continued Saudi dependency on oil is thought to be dangerous for a number of reasons. First, oil is a finite resource and reserves will eventually be exhausted. Second, the oil market is characterised by uncertainty and instability, because oil demand depends on many variables which are beyond the Saudi government's control, such as the performance of the world

economy, the availability of alternative energy sources, and the oil reserves of the industrial countries. Finally, the oil sector has weak linkages to the rest of the economy.

3.4.2 Oil as a Depleting Resource

One of the vital advantages of Saudi Arabia and oil producing countries lies in their possession of a resource that is readily converted into a large financial flow, much of it in the form of foreign exchange. However, Saudis must contend with the fundamental fact that their oil wealth is exhaustible[4]. This fact makes the Saudi government realise that the base of their economy is very weak, as long as it depends on export of a single depleting commodity (Al-Hasan, 1997).

This realisation led the planners to make every possible effort to diversify the economy, where continued dependence on oil revenue for socio-economic development is not a reliable option in the long term. Therefore, recent Five-Year plans for development (the fourth and fifth) emphasised economic diversification, which had to be done within a reasonable time period, otherwise the country might risk entering the 21st century within depleted oil resources, financial assets eroded by inflation, and much larger population.

Although Saudi Arabia has the largest proven oil reserve in the world, which is estimated to be around 160 billion barrels, or a quarter of the world's total

reserves (Field, 1985, p. 49), this resource is not enough to last (at 1997 levels of production) for more than forty years.

3.4.3 Oil Exports and Price Instability

One of the characteristics of many LDCs is their heavy reliance on primary exports, where primary commodities represent the major source of revenue and foreign exchange earnings. The high degree of dependency on a single commodity is believed to be more risky in the case of crude oil than any other primary goods, because the market has been characterised by a high degree of variability (instability) in the past twenty five years, as seen in Table 3.1.

Table 3.1: Trends in Average Price of Arabian Light Crude Oil

Year	US$/b[1]	Change (%)	Year	US$/b[1]	Change (%)
1960-1969	1.8	-	1983	28.2	-2.8
1970	1.8	0.0	1984	28.0	-0.7
1971	2.3	27.8	1985	21.0	-25.0
1972	2.5	8.7	1986	13.7	-34.8
1973	5.0	100.0	1987	17.2	25.5
1974	11.7	134.0	1988	13.4	-22.1
1975	12.0	2.6	1989	16.2	20.9
1976	12.4	3.3	1990	20.8	28.4
1977	13.7	10.5	1991	17.4	-16.3
1978	13.7	0.0	1992	17.9	2.9
1979	24.0	75.2	1993	15.7	-12.3
1980	32.0	33.3	1994	15.4	-1.9
1981	34.0	6.3	1995	16.7	8.4
1982	29.0	-14.7			

1 Official Prices up to 1980 and spot prices thereafter.

Source: SAMA (2000).

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[4] For basic arguments on the core theory of exhaustible resources, see Hotelling (1931).

This variability in the world market was very harmful to the oil exporting countries, especially Saudi Arabia, whose oil revenues slid from SR 328.3 in 1982 to less than SR 42 billion in 1986, as shown in Table 2.1. The variability of Saudi exports will be analysed and measured in more detail in Chapter 5, and a portfolio approach will be applied to show how Saudi exports' instability can be reduced.

3.4.4 Oil and Economic Linkages

In his study of OPEC countries and their economic problems, Amuzegar (1982) states that, unlike other activities which draw their inputs such as land, labour and capital from a wide variety of other smaller industries and in turn stimulate and induce a wide range of productive activities, oil offers few such backward and forward linkages. Petroleum remains a highly insulated and technologically advanced industry with little direct spill over into other economic sectors.

Oil-producing countries have realised that oil production has little direct impact on development of the sectors outside the oil fields. Thus the relationship between the oil sectors and the rest of the economy is fundamentally financial. In the oil-based economy countries such as Saudi Arabia, the country is supposed, by exporting oil, to trade the crude oil for foreign exchange, which is essential to import desired goods to build the country's infrastructure base, and obtain capital goods or machinery which are necessary to improve productivity.

For example, if we assume that domestic output in Saudi is a function of capital, labour, and infrastructure, then:

Output = f (capital, labour, infrastructure)

In the case of Saudi Arabia, capital is the abundant factor relative to the other factors of production. Johany et al. (1986) argue that if the country utilises its income from oil in building the country's infrastructure base, such as schools, ports, etc., such an act will increase the marginal productivity of the abundant factor, namely capital, through increasing the supply of the relatively scarce factor.

This happened when many Saudi planners, during the boom period in the 1970s and early 1980s, came to believe that the 'petrodollar' was capable of overcoming any economic obstacle, such as the poor infrastructure base and lack of skilled and trained labour. They were partially right, as the oil wealth enabled the country to increase the number of schools by 15% during the boom period, and university enrolment by more than fivefold from 9,000 in 1972 to about 50,000 in 1980. On the other hand, the oil sector has weak backward and forward linkages, with total employment accounting for less than 2% of the total labour force. This is attributable to the capital-intensive nature of the oil industry. The input-output approach is used in Chapters 6 to measure the oil and the rest of the Saudi economy sectors' linkage and multiplier impacts.

Due to depletability, market instability, and its weak backward and forward linkages, the Saudi government came to realise the limitations of dependency on oil exports. Therefore, it assigned a crucial role to the diversification of the economic base away from oil by investing in productive non-oil sectors, such as the industrial, agricultural and, recently, non-oil mineral sectors (Looney, 1990).

3.5 Role of the Non-Oil Industrial Sector

During the 1980s, the government established, virtually from scratch, a modern industrial sector. Saudi Arabia had virtually no industrial base in the early 1970s (Turner and Bedore, 1979). The industrialisation process had two goals: first, the use of the country's enormous gas production as industrial inputs to produce chemicals and petrochemicals for export, and second, the construction of energy-intensive industries, some for import-substitution purposes and others to meet infrastructure needs. The government also established industrial cities and facilities to support its industrial programme, including those at Al-Jubail and Yanbu.

By the early 1990s, the vast majority of these plants had been completed, and few major expansions were planned. Infrastructure requirements had largely stabilised and were adequate to meet the needs of the population and industry for much of the 1990s. Therefore, the government concentrated on maintenance of the infrastructure and on improving productivity and efficiency. To encourage more private sector investment in manufacturing, particularly in light industries, local business received incentives in the form of production and consumption subsidies.

3.5.1 Manufacturing

Oil revenues accrue directly to the government, and hence the public sector plays a pervasive and extremely large part in industrial activity and economic management. As a result, the government has played an instrumental role in developing the manufacturing sector by directly establishing industrial plants, mainly in the basic industries sector, such as petrochemicals, steel, and other large manufacturing enterprises. Also, it has developed manufacturing through direct loans, mainly by the Saudi Industrial Development Fund (SIDF), and through industrial subsidies, offset programmes, set-asides, preferential buying programmes, and tariffs. Accordingly, greater efficiency and more competitiveness were established during the late 1980s, where the number of manufacturing units established was about 3700 units, with an increase of 150 compared to the number of unit, established in the late 1970s. Most of these new manufacturing units concentrated basically on import substitutions, hydrocarbon or non- hydrocarbon industries (Ministry of Planning, 1999).

The private sector, on the other hand, has developed small-scale, light industries oriented towards the internal markets. Most of the private ownership of enterprises was traditionally concentrated in those areas which generated quick profit, such as real estate, trade, and service sectors. In the 1980s, the bulk of private manufacturing investment was directed to plants that manufactured goods for the construction industry. The building materials' industry was the first major manufacturing branch where private enterprise played a dominant role. This

industry benefited much from the boom construction activities during the boom years in the 1970s. The cement industry, for example, expanded rapidly because of escalating demand, domestically available raw materials, and generous finance provided by SIDF. Cement production grew from 0.8 million tons in 1973 to some 8.7 million tons in 1982, an average annual growth rate of 30.4%, and accounted for 57% of the total manufacturing employment.

Due to the completion of the infrastructure base in Saudi Arabia and the low oil income in the early 1980s, the cement industry experienced a low growth rate. The early recession of the 1980s led to the closing of many of the less efficient manufacturing projects established during the boom of the 1970s. The cost of building and operating industries was reduced by 50%, mainly because of reductions in the cost of real estate, rents, labour, and building materials (Looney, 1990).

Partly because of private sector reluctance to invest in manufacturing, and partly because of growing oil revenues, the government was involved early in the 1960s in some basic industries. In the late 1960s, Petromin established a steel- rolling mill in Jeddah using imported billets, a urea fertiliser plant in Ad Dammam with 49% private Saudi capital, and a sulphuric acid plant in the same location. In the early 1970s, as oil revenues grew, a co-ordinated plan emerged to collect and distribute gas that was flared to two yet unbuilt industrial sites, where it could be used in basic industries. The two sites selected were Al-Jubail and Yanbu.

In 1975, the Royal Commission for Al-Jubail and Yanbu was created. The commission was given authority to plan, construct, manage, and operate the infrastructure needed to support the basic industries the government intended to build, and to satisfy the community needs of the work force employed in these industries. The commission was also to promote investment in secondary and supporting industries, to develop effective city government, and to train Saudis to take over as many jobs as possible. The commission received an independent budget to facilitate its work.

By 1990, there were 16 primary industries, 46 secondary enterprises, and approximately 100 support and light industrial units at Al-Jubail. Yanbu, meanwhile, had attracted 5 primary industrial plants, 25 secondary plants, and 75 support and light units. Although Al-Jubail benefited from the massive petrochemical projects of SABIC, both cities saw substantial growth during the 1980s (Choudhury and Al-Sahlawi, 2000).

With the establishment of SABIC in 1976, the government undertook a major effort to create a domestic petrochemical industry that was designed to augment oil export earnings and to use abundantly available domestic resources, particularly associated gas supplies. The investments were guided by a two-phase strategy. The first phase (1976-1987) included a number of large capital-intensive and export-oriented petrochemical projects that have been completed. Its aim was to produce bulk products such as ethylene, polyethylene, melamine, methanol, and downstream products, including derivatives of ethylene. Moreover, during this

period, SABIC undertook the construction of plants to produce fertilisers (urea, sulphuric acid, and melamine), metals (steel rods and bars), supporting industrial products (nitrogen), and intermediate petrochemical products (vinyl chloride monomer and polyvinyl chloride). SABIC also acquired shares in two Saudi aluminium companies and expanded overseas by investing in a Bahraini petrochemical complex.

During the first phase, financing by joint venture partners and funding from the government's Public Investment Fund (PIF) provided the bulk of support for these projects. Domestic and regional private sector participation was also allowed after 30% of the equity capital of SABIC (approximately SR 3 billion) was sold to residents of Saudi Arabia and other GCC countries. In 1987, SABIC split each share into ten shares to mobilise investments from smaller investors (Bardesi, 1996).

In 1995, SABIC owned, either outright or with a minimum 50 % stake, fifteen major industrial enterprises. Total output capacity was 13 million tons of various petrochemicals per year, up from 11.9 million tons per year in 1990 and 9.5 million tons per year in 1989. Although total sales continued to rise, weaker international prices depressed profits during the late 1980s and early 1990s. During 1991, SABIC registered net profits of SR 2.3 billion. About 95% of SABIC's sales were exported; total exports approached SR 16 billion per year. Its success in rapidly increasing exports and capturing an international market share have made SABIC's petrochemical exports subject to non-discriminatory restraint

in both EEC and Japan, its main export markets. Both the EEC and Japan have applied quantitative restrictions to Saudi exports. Moreover, urea exports from Saudi were subject to antidumping duties in the EEC, which no longer permitted preferential treatment under its General System of Preferences.

SABIC's second phase plans were designed to maintain Saudi Arabia's 1992 international market share and raise domestic petrochemical capacity by 40%. Because the available gas-based feedstocks (ethane and methane) were insufficient to meet requirements of the second phase, SABIC invested in two flexible feedstock crackers with a total combined capacity of about 1 million tons. The crackers helped reduce dependence on ethane and methane, and allowed the use of naphtha, liquefied petroleum gas or propane as feedstock.

Moreover, with the onset of serious budgetary constraints, the government's role in advancing the domestic industrialisation process grew more indirect. The government was forcing a number of state-owned industrial institutions to seek financing for their new, capacity-expansion programmes from non-traditional sources, such as domestic and foreign commercial banks, stock markets, and private investors. In SABIC's second phase, 30% of financing plans (SR 15 billion) was borrowed from the domestic and international commercial banks (Bardesi, 1996).

As mentioned above, the private sector's role in industrialisation was largely restricted to light and medium-sized manufacturing units. However, some larger

merchant families had established larger-scale chemical, secondary-stage petrochemical, and car or truck assembly plants. By 1981, Saudi Arabia had approximately 1,200 industrial plants of all sizes. At the end of the 1980s, this figure had doubled to about 2,000 units, and had risen to 2,533 by 1995. Most private manufacturing concerns in the 1980s produced construction materials, including cement, insulation materials, pipes, bricks, and wood products. Judging from data available from the Ministry of Industry and Electricity, there has been a marked shift from this sort of production to downstream chemicals, food processing, and metals, machinery, and equipment manufacturing. The annual number of new licences issued to companies in the chemical, rubber, and plastics sector rose from seven per year in 1987 to fifteen in 1990. Although this number constituted, at most, 20% of all licences granted, the size of the firms was growing, judging from their authorised capital, which grew from 42% of total new investment planned to 90%. Trailing well behind this sector was the food-processing sector, which saw a rise in number of licences between 1987 and 1995, but the volume of authorised capital declined, indicating smaller individual companies and more widespread participation. Metals and machinery manufacturing followed a pattern similar to chemical companies, with both the number of units and authorised capital growing during the same period (Vassiliev, 1998).

The patterns of Saudi private manufacturing investment conformed to government investments. Incentives offered to private businesses included interest-free loans from SIDF of up to 50% of the cost an industrial project, repayable within fifteen

years. Exemptions from tariff duties on imported equipment, raw materials, spare parts, and other industrial inputs; land leases at significantly reduced prices; discriminatory buying practices by government agencies; and significant import protection, were some of the other incentives provided.

However, the decision to increase the country's oil and gas resource development through downstream investments in refineries and hydrocarbon' (petrochemicals) plants was logical. Considering the country's resource endowment, Saudi planners applied the Heckscher-Ohlin theory of international trade. Three factors motivated such a policy. Firstly, downstream investments were capital-intensive, which fitted the Saudi relatively small population and large oil revenues. The petrochemicals' industry enjoys one of the highest capital-to-labour ratios in the world. Looney (1982), for example, estimates the investment per job created between $20,000 to $100,000. Secondly, more value added revenue would be extracted and retained, thereby maximising Saudi revenues through the export of more refined petroleum products instead of crude oil. Finally, the natural gas that had been largely wasted before the 1980s would be processed and used.

However, the Saudi petrochemical industry strategy came under criticism. Some economists, such as Turner and Bedore (1979), argued that the market for the products of large refineries and petrochemical plants in Saudi Arabia was relatively small. Most of the output would be sold in the international markets, and the western nations would not welcome additional competition. Competition was also coming from other OPEC members, such as Iran and Algeria. As a

result, there was a trade war using quotas and tariffs. Turner and Bedore argued that there were at least eight variables which will affect the economic viability of Saudi capital-intensive ventures. Only two of these variables (feedstock prices and capital availability) were clearly in favour of the Saudis, with one other (environmental issues) cutting both ways. Three factors (high construction, fixed operating and high transport costs) would probably always work against the Saudis, and two others (markets and tariffs) were currently working against them.

3.5.2 Agriculture

During the 1970s and 1980s, the government undertook a massive restructuring of the agricultural sector. The stated objectives were food security through self-sufficiency and improvement of rural incomes. Although successful in raising domestic output of several important crops and foodstuffs through the introduction of modern agricultural techniques, the agricultural development programme did not entirely meet these objectives. In regard to self- sufficiency, the country produced a sufficient surplus to export limited quantities of food. However, if the entire production process were considered, the import of fertilisers, equipment, and labour made the country even more dependent on foreign inputs to bring food to the average Saudi household (Olsen, 1994).

Two patterns of income distribution emerged. Traditional agricultural regions did not benefit from the development programme, and the government's financial support led to the establishment of large-scale agricultural production units. Some of these were managed and operated by foreign entities, and owned by wealthy

individuals and large businesses. From an environmental viewpoint, the programme had a less than satisfactory impact. Not only did it cause a serious drain on the Saudi water resources, drawing mainly from non-renewable aquifers, but it also required the use of massive amounts of chemical fertilisers to boost yields. In 1995, Saudi agricultural strategy was only sustainable as long as the government maintained a high level of direct and indirect subsidies, a drain on its budget and external accounts.

Until the 1970s, sedentary agriculture saw few changes, and declined in the face of foreign imports, urban drift, and lack of investment. The use of modern inputs remained relatively limited. Introduction of mechanical pumping in certain areas led to a modest level of commercial production, usually in locations close to urban centres. Nevertheless, regional distribution of agricultural activity remained relatively unchanged, as did the average holding size and patterns of cultivation.

During the late 1970s and early 1980s, the government undertook a multifaceted programme to modernise and commercialise agriculture. Indirect support involved substantial expenditures on infrastructure, which included electricity supply, irrigation, drainage, secondary road systems, and other transportation facilities for distributing and marketing produce. Land distribution was also an integral part of the programme. The 1968 Public Lands Distribution Ordinance allocated 5 to 100 hectares of fallow land to individuals at no cost, up to 400 hectares to companies and organisations, and a limit of 4,000 hectares for special projects. The beneficiaries were required to develop a minimum of 25% of the land within a set

period of time (usually two to five years); thereafter, full ownership was transferred. In 1989, the total area distributed stood at more than 1.5 million hectares. Of this total area, 7,273 special agricultural projects accounted for just less than 860,000 hectares, or 56.5%; 67,686 individuals received just less than 400,000 hectares or 26.3%; 17 agricultural companies received slightly over 260,000 hectares, or 17.2%. Judging from these statistics, the average fallow land plot given to individuals was 5.9 hectares, 118 hectares to projects, and 15,375 hectares to companies, the latter being well over the limit of 400 hectares specified in the original plans (Findlay, 1994).

The government also mobilised substantial financial resources to support the raising of crops and livestock during the 1970s and 1980s. The main institutions involved were the Ministry of Agriculture and Water, the Saudi Arabian Agricultural Bank (SAAB), and the Grain Soils and Flour Mills Organisation (GSFMO). SAAB provided interest-free loans to farmers; during 1989, for example, 26.6% of loans were for well drilling and casing, 23% for agricultural projects, and the balance for the purchase of farm machinery, pumps, and irrigation equipment. SAAB also provided subsidies for buying other capital inputs (Olsen, 1994).

GSFMO implemented the official procurement programme, purchasing locally produced wheat and barley at guaranteed prices for domestic sales and exports. The procurement price was steadily reduced during the 1980s because of massive overproduction and for budgetary reasons, but it was substantially higher than

international prices. By the late 1980s, the procurement price for wheat, for example, was three times the international price. Although quantity restrictions were implemented to limit procurement, pressures from a growing farm lobby led to ceiling-price waivers. Moreover, the government encountered considerable fraud, with imports being passed off as domestic production. To control this situation, the government granted import monopolies for some agricultural products to the GSFMO, while procurement and import subsidies on certain crops were shifted to encourage a more diversified production programme. Finally, agricultural and water authorities provided massive subsidies in the form of low-cost desalinated water, and electric companies were required to supply power at reduced charges.

The programme prompted a huge response from the private sector, with average annual growth rates well above those programmed. These growth rates were underpinned by a rapid increase in land brought under cultivation and agricultural production. Private investments went mainly into expanding the area planted for wheat. Between 1983 and 1995, the average annual increase of new land brought under wheat cultivation rose by 14%. A 35% increase in yields per ton during this period further boosted wheat output; total production rose from 1.4 million tons per year in 1983 to 3.5 million tons in 1989, and declined to 1.6 million tons in 1995. Other food grains also benefited from private investment. For example, output growth rates for sorghum and barley accelerated even faster than wheat during the 1980s, although the overall amount produced was much smaller. During the 1980s, farmers also experimented with new varieties of vegetables and

fruits, but with only modest success. More traditional crops, like onions and dates, did not fare as well and their output declined or remained flat (Findlay, 1994).

In the 1970s, increasing incomes in urban areas stimulated the demand for meat and dairy products, but by the early 1980s, government programmes were only partially successful in increasing domestic production, much of the meat consumed being imported. Although the meat supply was still largely imported in the early 1990s, domestic production of meat had grown by 33% between 1984 and 1995, from 101,000 tons to 154,000 tons. This increase, however, masked the dominant role of traditional farms in supplying meat. Although new projects accounted for some of the rapid growth during the 1980s, a sharp decline of roughly 74% in beef stock production by specialised projects during 1989 resulted in only a 15% fall in meat output. This reversal also highlighted the problems in introducing modern commercial livestock-rearing techniques to the country (Olsen, 1994).

Commercial poultry farms, however, greatly benefited from government incentives, and grew rapidly during the 1980s. Chickens were usually raised in controlled climatic conditions. Despite the doubling of output, as a result of the rapid rise in chicken consumption, domestic production constituted less than half of total demand. Egg production also increased rapidly during the 1980s. The numbers of broiler chickens increased from 143 million in 1984 to 390 million in 1995, while production of eggs increased from 1,852 million in 1984 to 2,500 million in 1995.

Fishing, however, was an underdeveloped aspect of the Saudi economy, despite the abundance of fish and shellfish in coastal waters. The major reasons for the small size of this sector were the limited demand for fish, and the comparative lack of fish marketing and processing facilities. Iraqi actions in releasing oil into the Arabian Gulf during the Gulf War caused appreciable damage to fish and wildlife in the Gulf. The Saudi Meteorology and Environment Protection Agency (MEPA), with the co-operation of other international organisations, had launched a massive programme to reduce the damage effect and eventually restore the wild life. These efforts took several years and the only fishing source was on the other side of the country, namely the Red Sea. In 1995, Saudi total catches on both seas were at more than 48,000 tons.

Despite the government subsidies, it has been shown that there are many constraints on the development of a serious and soundly based agriculture in Saudi Arabia. According to McLachlan (1984), the two greatest difficulties are represented by the age-old problem of a harsh and unforgiving environment, on the one hand, and the complexities of accommodating agriculture to the economic regime of the oil-based economies in which agriculture is a poor competitor for water, labour and financial resources, on the other. On present evidence, of the two limiting factors, it might prove to be the environment that is most damaging to the future prospects for agriculture development in the Saudi Arabia.

Moreover, observers have also criticised the Saudi philosophy on self-sufficiency in food. Rustow (1983), for instance, argues that such a philosophy was not

justified for three reasons. First, international experience has shown that food embargoes have generally failed unless accompanied by a major military campaign. Second, savings on food purchased from overseas could easily have been invested in inventory to safeguard against an external threat. Third, no social benefit is gained from such a programme. Agricultural employment continued to decline, and large companies, rather than peasant farmers, profited from most subsidies. Finally, subsidies could have been related to more appropriate production methods that promoted water conservation.

3.6 Conclusion

Saudi Arabia does not face the problems of other developing countries, which must first secure capital and then proceed with development procedures. A considerable amount of the large oil revenues was invested heavily in industrialisation, in an attempt to diversify the economy away from the crude oil. Adopting a balanced growth strategy, Saudi Arabia was ranked among the major industrial economies in the Middle East in 1992.

However, most Saudi industries were oil and natural gas-based, in the public sector, and heavily dependent on subventions from the government budget. The private sector was reluctant to establish domestic processing plants, and those created had been heavily subsidised. Similarly, modern, water-intensive, and import-dependent agriculture came at a huge cost to the government. Moreover, there were many complex obstacles and limitations that hindered the development of the industrial sector, such as manpower shortages, lack of technical and

managerial know-how, and the lack of entrepreneurs capable of utilising investment capital efficiency. As a result, the non-oil sector remains relatively weak in terms of diversifying the economy away from oil as the major source of Saudi revenues.

The non-oil minerals industry, as a sub-sector of the non-oil, will be introduced separately in the next chapter. The reason behind that is to examine its role in the Saudi Arabian economy in the period between 1970 and 1995 in more detail.

Chapter 4: Background to Saudi Arabian Non-Oil Minerals Sector

4.1 Introduction

The previous chapter has shown that the oil sector is the most important pillar of the Saudi Arabian economy, while the non-oil sector has a relatively weak role. In this chapter, we are going to examine the non-oil minerals sector and its role in the Saudi Arabian economy. Specifically, we will examine the sector's direct contribution to the Saudi Arabian economy. This examination is mainly of GDP, government revenues, balance of payments, foreign exchange savings and employment. However, before we examine this contribution, we feel that a general overview of the sector is needed. The present chapter provides the background to the Saudi Arabian non-oil minerals sector and its industrial base. Specifically, the chapter gives an overview of the main known mineral resources in Saudi Arabia, the production as well as the structure of the sector industry. Finally, the chapter highlights the main government incentives to develop the sector.

4.2 Known Non-Oil Mineral Resources

The geology of the Saudi Arabia may be divided, as shown in Figure A.2, into two main terrains. The first is the Arabian Shield area in the west, adjacent to the Red Sea and covering one-third of the country. The second terrain is the area where the sedimentary rocks dip toward the Arabian Gulf, called the cover rocks. Saudi Arabian mineral deposits are located in both terrains. The metallic deposits, such as gold, copper, zinc and iron, are mainly associated with the rocks of the

Arabian Shield. The phosphate, bauxite, dolomite and gypsum deposits are located further to the east, in the cover rocks.

The Saudi Arabian government owns all subsoil resources. As a result, all natural deposits of minerals and quarry deposits are the government's exclusive property. The Saudi Arabian Ministry of Petroleum and Mineral Resources (MPMR) is the governmental agency that is responsible for both oil and non-oil minerals sectors in the country. MPMR is the sole agency concerned with the application and administration of mining in the country. The Deputy Ministry of Mineral Resources (DMMR) is the governmental legislative agency which issues licences and protects the government's rights in mining. DMMR is also responsible for geological survey, non-oil mineral exploration, geological services, and the promotion of mining investment in Saudi Arabia.

Due to an extensive exploration effort sponsored by DMMR and undertaken by known organisations, including the US Geological Survey (USGS), the Bureau de Recherches Geologiques et Mines (BRGM) from France, Riofinex Ltd from the UK, and the Canadian Watts Griffis McOuat, since the 1950s Saudi Arabia has collected reasonably accurate data on the country's non-oil mineral potential. A summary of Saudi Arabian known non-oil mineral deposits, indicating the main regions of mineralisation, is given in Table A.1, where 33 minerals are listed.

More than 5 metallic and 15 industrial minerals were mined in Saudi Arabia in 1995. Of the metallic ores, the gold deposits are of world importance because of

both their value and quantity. Some estimates suggest that Saudi Arabia is home to 20 million tons of gold ore. The gold deposits have significantly contributed to meeting the needs of the 2,000-ton domestic market, as well as that of foreign markets such as India, Europe, and the United States. Very large deposits of comparatively moderate-value industrial minerals, such as marble, magnesium, dolomite, rock salt, cement raw materials, glass and ceramic minerals, refractory clays, zeolites, phosphate, and bauxite are found. According to DMMR (1996), some minerals can yield 60 downstream products, while for other minerals, the Fursan mountains, for example, have 3 million metric tons of marble deposits, and it was projected that 22 factories could be set up for harnessing these resources.

A brief description of some of these deposits, with comments regarding their development potential, is given below. This information is primarily based on economic assessments and feasibility study reports issued by DMMR (Collenette and Grainger, 1994; and DMMR, 1998b).

4.2.1 Metals

Copper and zinc

Saudi Arabian land holds reserves of over 60 million tons of copper minerals. DMMR has recently invited private investors to bid on an exploration licence centred on the Jabal Sayid deposit, located approximately 150 km from Al Madinah, and believed to contain 20 million tons of copper ore. Japanese government agencies have recently been awarded a licence to explore for copper

in the western region of the country (Michalski, 1997). The Al-Masane polymetallic sulphide deposit has reserves of 7.2 million tons grading 5.3% zinc, 1.4% copper, 1.2 grams/ton gold, and 40.2 grams/ton silver. The Al-Masane deposit, licensed to the Arabian Shield for Mining Industries Company (ASMIC) continues to be studied. A pre-feasibility study conducted by DMMR on the Khnaiguiyah zinc deposit established reserves of 1.9 million tons grading 15.3% zinc and 0.9% copper mineable underground, or 3.2 million tons 12.2% zinc and 0.8% copper possibly mineable by open pit. DMMR projections suggest an annual production rate of 34,400 tons of 56% zinc concentrates.

Gold

Several commercially significant gold deposits have been discovered in the Arabian Shield. There is potential development for three gold mines at Al-Hajar, Al-Amar, and Bulghah. The Al-Hajar project is under construction by the state-owned company, Saudi Arabian Mining Company (Ma'aden), at a target capital cost of less than SR 93.6 million, with an annual productive capacity of 55,000 ounces of gold and 236,000 ounces of silver, starting in 2001. Al-Amar and Bulghah, with 30 million tonnes resource potential, have ongoing finalisation of engineering or feasibilities, where the Al-Amar underground deposit could represent a production of between 60,000 and 90,000 ounces of gold per year, and the Bulghah open pit a similar amount. In December 1998, Ma'aden was also granted a licence to explore for gold at the Dowaihi, in the Makkah region. This site is believed to contain 14,000 kilograms of gold. Exploration is also in progress at Al Suq, and the Samran, Shayban and Hamdah prospects.

Iron Ore

Saudi Arabia has several iron ore deposits, including the Wadi Sawawin deposit. The Wadi Sawawin iron ore deposit holds reserves of 84 million tons at 42.5% iron, sufficient for 25 years of pellet production at 2.2 million tons/year. Various plans for transporting the concentrate include ideas of a 60 km slurry pipeline to a Red Sea coastal plant for processing into direct-reduction pellets.

4.2.2 Industrial Minerals

Magnesite

Saudi Arabia is home to the world's largest deposits of magnesite. Two sites containing impressive amounts of magnesite have already been identified. The first, located in the Zarghat area about 400 km northeast of Al Madinah, contains 1.6 million tons of magnesite. Based on a completed feasibility study, the ores from this site are estimated to yield 20,000 tons/year of high-grade electrofused magnesia to be used in global refractory markets. The other major magnesite site is in Jabal Rukman, about 180 km southeast of Al Madinah. Also, one of the main sources of magnesium is dolomite found in Huraysan, 60 km east of Al Kharj. Another extensive source of dolomite is the Wadi Ar'ar deposits, covering more than 100 sq. km on both sides of the Al Jawf-Ar'ar highway, in the north western part of the country.

Phosphate

Saudi Arabia holds some of the largest phosphate deposits in the world, located mostly in the north and north-western regions. The deposits at Turayf and Sanam, and the impressive Al Jalamid deposits, are estimated to be several hundred million tonnes. According to Ma'aden's estimates, the Al Jalamid deposit alone will allow for the exploitation of some 200 million tons of phosphate, which will support a 20-year mining operation in the country. Ma'aden has recently announced that an additional number of world-class phosphate deposits have been identified across the northern part of the country. With private sector investment, Saudi Arabia can locally exploit the produced phosphate to consolidate its position as third exporter of fertilisers in the world (Spencer, 1999). DMMR anticipates that the country will capture 16% of the world phosphate market. Identified future markets for phosphate include China, India, Japan, Pakistan, and Iran.

Bauxite

Extensive exploration and testing have been conducted on the proven deposit of Az Zabirah, situated about 650 km west-northwest of Al-Jubail. Resource estimation and pre-feasibility studies have been conducted by DMMR. Tests have shown that bauxite at this site is amenable to the Bayer Process of alumina production. Total reserves would allow open-pit mining at an annual rate of 2.5 million metric tons initially, for at least 20 years. The Az Zabirah deposit has the potential to supply an aluminium industry in the GCC. Several other sites in the

country are being investigated for bauxite, including Al-Zughbiyah and Al-Tiniyat.

4.3 Production of Non-Oil Minerals and Commodities

Statistics drawn from official data and showing the development of Saudi Arabian production of major non-oil minerals and commodities over the past decade are given in Table 4.1.

Table 4.1: Production of Non-oil Minerals and Commodities in Saudi Arabia (1989-1998)

(Million metric tons unless otherwise specified)

Commodity	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Copper[1]	0.8	0.9	0.9	0.9	0.9	0.9	0.9	0.8	0.7	0.7
Cement[2]	11.4	12.0	11.4	15.3	15.3	16.0	15.8	16.5	15.4	21.2
Gold (ton)[3]	3.6	5.6	4.3	5.6	7.5	7.6	8.1	7.5	7.3	7.3
Gypsum	375.0	375.0	375.0	269.3	326.7	375.0	375.0	417.0	453.0	430.0
Iron and Steel[4]	1.8	1.8	1.8	1.8	2.3	2.4	2.5	2.6	2.5	2.5
Silver (ton)[1&3]	13.3	16.2	16.4	17.8	18.0	17.0	16.9	16.0	16.9	16.9
Zinc[1]	2.6	2.5	2.5	0.5	0.5	0.5	0.5	0.6	0.6	0.6
Lime	12.0	12.0	12.0	12.0	12.0	12.0	11.8	12.4	11.6	14.0
Lead[1]	0.2	0.3	0.2	0.2	0.1	0.1	0.1	0.2	0.2	0.3
Synthetic Fertiliser	N/A	N/A	N/A	N/A	N/A	1.5	2.0	2.1	2.1	2.1

[1] As a by-product of old production at Mahd Ad Dhahab.
[2] Thousand tons.
[3] As concentrate and bullion.
[4] Metal, steel, and crude.
Source: DMMR (1998b).

Minerals mined and produced in Saudi Arabia but not included in Table 4.1 are salt, granite, red bricks, ground calcium carbonates, glass, ceramics, aggregate, mosaic floor tiles, barite, sodium silicates and caustic soda. Saudi Arabian major

minerals' production comprises cement raw materials, gypsum and ceramics. Gold, silver, copper, zinc, iron and lead are produced in moderate volumes and, therefore, are mostly consumed in the domestic market as a result of the expansion of manufacturing industry based on these metals during the past two decades. In minerals and mineral-based products, Saudi Arabia is a large importer of iron ore, phosphate rock, aluminium raw materials, and gold.

The large-scale expansion of domestic mineral-based industry during the past 15 years has resulted in a steep rise in the production. For instance, the eight cement factories finished their planned expansion, and increased their capacities by 40% in 1998. The output expansion of iron and steel and fertiliser production have been based on imports of their raw materials such as iron ore, coking steel scrap, phosphoric acid and potassium chloride. In 1998, the total mineral-based industry was 351 factories with a total cost over SR 28 billion.

4.4 Structure of Non-oil Mineral Industry

The private sector is involved in all mining operations except in gold mining. The government-owned company, Ma'aden, is the only company authorised to engage in gold mining in Saudi Arabia. Mineral-based industry is carried out by both sectors, and they share some industry together. A review of the major commodities and mineral-based industries is introduced in the next section.

Gold

Gold is primarily extracted by Ma'aden from two gold mines, Mahd ad Dhahab and Sukhaybarat. According to Ma'aden, Mahd ad Dhahab will continue to produce approximately 90,000 ounces of gold, 300,000 ounces of silver, in addition to copper and zinc, for the next seven to ten years. The Sukhaybarat gold mine is an open pit, working with grades of 1.4 grams/ton. Gold reserves at that site are sufficient for three years at the current production rate of 50,000 ounces annually. Ma'aden has recently bought the 50% stake held by the Swedish Boliden, Ltd., its joint venture partner in the Sukhaybarat mine, for the amount of SR 25.8 million. This purchase makes Ma'aden the sole owner of the Saudi Company for Precious Metals (SCPM). Ma'aden's combined gold production in 2000 was 140,000 ounces, at an average cost of less than $195 per ounce.

The Dahab Co. Ltd., a Saudi Arabian/French joint venture opened, a gold refinery at Jeddah with a capacity of 110 tonnes/year gold and 20 tonnes/year silver, opened in 1998. The Saudi private sector holds 51% of the company, while the French concern, Thomson CSF, holds the remaining 49%. It refines local scrap plus bullion from Mahd Ad Dhahab and Sukhaybarat gold mines.

Aluminium

The Saudi Arabian government holds an equity share of an aluminium smelter (ALBA) in Bahrain with the Bahraini government. In 1996, ALBA production was 0.5 million tonnes of primary aluminium. Because demand for aluminium exceeds ALBA production, Saudi Arabia continues importing aluminium. In

1997, the Saudi import of aluminium was 0.3 million tonnes. In 1997, Saudi Aluminium Recycling Co. opened a new plant at Jeddah on the Red Sea. The plant, a joint venture between the Saudi private sector and the Processing Co. of Germany, has a capacity to produce 18,000 tonnes/year.

Copper

Until 1998, copper was a by-product of gold mining at Mahd Ad Dhahab. A new copper smelter and refinery plant started up in 1998. The plant, located at the second largest industrial city on the Red Sea, Yanbu, produces 150,000 tonnes/year of copper cathode. Saudi Arabia imported an extra 40,000 tonnes of copper in 1997.

Ferroalloys

In 1998, the Gulf Ferroalloys Co. (Sabayek) constructed a ferroalloy complex at Al- Jubail, a location accessible to high-quality quartz and inexpensive energy. The complex has a 35,600 metric tonnes/year capacity ferrosilicon plant, a 10,000 metric tonnes/year silicon metal furnace, and a 27,600 metric tonnes/year silicomanganese and 10,000 metric tonnes/year ferromanganese production. Sabayek's total cost was SR 236 million, and its major equity owners are United Gulf Industries Corp. 26%, SABIC 15% and Demetal A. 7%. The remainder is owned by various Arab investors and financial institutions.

Iron and Steel

Saudi Iron and Steel Co. (Hadeed) at Al -Jubail is the only plant for steel in Saudi Arabia. Hadeed cost about SR 3.6 billion, and produces about 2.4 metric tonnes/year from steel scrap and imported pellets. The plant supplies 50% of the domestic market.

Cement

The domestic cement industry accelerated its expansion programmes to meet a greater portion of the growing demand, currently estimated at 18 million tonnes/year. The eight cement plants produced about 20 million ton/year, with net profit estimated at SR 1.7 billion in 1997. Saudi Arabia exports 2.4 million tonnes of cement, estimated at SR 0.6 billion in 1997. Five cement plants are 100%-owned by the Saudi government, the other three are shared with the private sector, with the government as the majority shareholder. The total investment in cement plants in Saudi Arabia is estimated at SR14 billion.

Fertilisers

A reorganisation of the Saudi Arabian fertiliser industry was implemented by the merger of the three state-owned companies, Ibn Albaytar, Safco, and Samad. The merger was intended to increase capacity and boost earnings, as a part of a general effort to reduce the budget deficit. These companies have the combined capacity to produce more than 2 million tonnes/year of fertilisers from their 5 plants. The total cost of the Saudi Arabian fertilisers plants is estimated at SR 2 billion.

4.5 Contribution of the Non-oil Minerals Sector to the Saudi Arabian Economy

In spite of its relatively long history of mining and the large non-oil mineral resources potential, mining constituted only about 0.3% of Saudi Arabian GDP between 1970 and 1995. The sector has not made up more than 0.4% in the past two decades because of the lack of capital available for mining investment from either public or private funds.

Table 4.2: Average Share of Non-Oil Minerals, Manufacturing and Agriculture in Saudi Arabian Fixed Capital Investment (1970-1995)

(Current values in SR, millions)

Year	Non-Oil Minerals		Manufacturing		Agriculture	
	Value	Share (%)	Value	Share (%)	Value	Share (%)
1970	38	13.7	91	32.7	10	3.6
1971	37	11.7	111	35.1	10	3.2
1972	35	11.8	102	34.5	11	3.7
1973	24	4.5	221	41.7	20	3.8
1974	40	2.4	760	45.6	34	2.0
1975	30	1.4	1011	46.9	38	1.8
1976	59	2.7	1000	45.6	38	1.7
1977	98	3.7	1161	43.6	74	2.8
1978	274	6.0	1854	40.8	147	3.2
1979	580	9.2	2408	38.1	169	2.7
1980	637	7.4	3460	40.0	232	2.7
1981	256	2.4	4587	43.7	408	3.9
1982	216	2.1	4503	43.2	495	4.8
1983	163	1.2	5667	41.8	931	6.9
1984	437	2.9	6099	40.0	1073	7.0
1985	663	4.6	5427	37.9	1045	7.3
1986	310	2.3	5452	40.2	990	7.3
1987	322	2.7	4749	39.2	967	8.0
1988	549	4.8	4126	36.1	1019	8.9
1989	382	3.4	4083	36.4	1124	10.0
1990	253	1.9	5138	38.9	1193	9.0
1991	449	2.7	6324	37.6	1604	9.6
1992	514	2.6	7294	36.8	2071	10.5
1993	670	2.6	9580	36.5	2853	10.9
1994	810	2.5	12883	39.3	2708	8.2
1995	558	1.9	12187	42.2	1669	5.8

Source: Ministry of Planning (1999).

As indicated in Table 4.2, the share of Saudi Arabian total fixed capital investment allocated to mining during the period 1970-1995 varied between 1.2% and 13.7%, the average for the period being about 4.4%. Because of the gradually decreasing rate of fixed investment in mining during the past 13 years, the average annual growth rate of mining has lagged behind those of manufacturing and agriculture, and of the economy as a whole. The averages for 1983-1995 were 2.8% for mining, 38% for manufacturing industry, and 8.4% for agriculture.

From further study of data given in Table 4.3 below, a general appraisal can be made as to Saudi Arabian balance of trade in non-oil minerals.

Table 4.3: Imports and Exports of Saudi Arabian Non- oil Minerals (1984-1995)
(Millions SR)

Year	Non-oil Minerals Imports	% of Non-oil Minerals in total Imports	Non-oil Minerals Exports	% of Non-oil Minerals in total Exports
1984	24369	20.5	345	0.3
1985	17626	20.6	589	0.6
1986	11334	16.0	795	1.1
1987	11203	14.9	1119	1.3
1988	12779	15.7	1674	1.8
1989	12717	16.1	1666	1.6
1990	16480	18.3	1895	1.1
1991	18152	16.7	1380	0.8
1992	20323	16.3	1025	0.6
1993	17735	16.8	1032	0.7
1994	14072	16.1	1567	9.9
1995	17969	17.1	1954	10.5

Source: Researcher's calculations based on SAMA (1998).

Unlike oil and gas, Saudi Arabia has been a large importer for decades. It is the largest import market in the region and one of the top 15 importers in the world. In 1999, the country was estimated to have imported around SR 108.6 billion

worth of goods (United Nations, 2000). Between 1984 and 1995, the share of non-oil mineral commodities in total imports varied between 14.9% and 20.6%, with an average of 17.1%. During the same period, the relatively high values of non-oil minerals imported to Saudi Arabia resulted in an outflow of hard currency payments of more than SR 212 billion. The main non-oil mineral commodities imported in large volumes are gold, iron ore, phosphate rock, ceramic and glass.

The value of non-oil minerals in Saudi Arabian exports was much lower than that of manufacturing products. As indicated in Table 4.3, the share of mining products in total Saudi Arabian exports was relatively low, and varied between 0.3% and 9.9% in 1984 and 1995, respectively. Saudi Arabian main exports of major mineral commodities are ceramic products, glassware, stone articles, plaster, gems, and cements.

Table 4.4 below indicates the development of workers in the non-oil mineral sector. The sector's workers have increased, and peaked to about 63 thousand workers in 1985. The figure has fluctuated, and dropped by more than 20% in 1990, and increased again to 59.1 thousand workers in 1995. In terms of employment generation in the economy, the sector showed a very low percentage of the whole Saudi Arabian labour force. The share of the sector's workers did not exceed more than 3% between 1965 and 1995, and tended to decrease over time. This low contribution to employment could be attributed mainly to the 'Dutch disease' effect. Such an effect would transfer the workers, due to high wages, from the tradable sector to the booming sector inside the economy. Another

reason could be that the mining industry is becoming more advanced by gradually replacing more workers with new machines.

Table 4.4: Development of Non-oil Mineral Sector's Workers (1965-1995)

Year	1965	1970	1975	1980	1985	1990	1995
Workers (thousands)	25.2	25.7	45.6	47.0	62.9	52.3	59.1
% of total Saudi Workers	2.5	2.3	3.0	1.6	1.2	0.9	0.9

Source: Ministry of Planning (1999).

4.6 Development of the Saudi Arabian Non-oil Mineral Sector

Despite its poor contribution to the Saudi Arabian economy, the government believes that the non-oil mineral sector could contribute significantly and, hence, is trying to enhance its role in the economy. Non-oil minerals have been highlighted in the Sixth Five-Year Development Plan (1996-2000), and there are big ambitions for the part they can play in the future prosperity of the country. According to the Sixth Plan, the sector is expected to grow at a target rate higher than any other sector of the economy. This optimistic growth rate is partly explained by the low base from which this sector is expected to expand, yet major mining projects are already out to tender and promise to enlarge the industry substantially. Others are expected to move forward in the coming years.

The Saudi Arabian government has identified mining as an essential element in its programme to diversify the economy away from its present dependency on oil. The government's medium and long-term objectives for this sector include

reaching out to private and foreign investors to establish industries for extracting and processing the minerals, and providing the Saudi manufacturing sector with its requirements in raw materials, as well as making Saudi Arabia a leading exporter of minerals. With such a vast country as Saudi Arabia, the government has focused not only on finding the mineral deposits, but also on making them accessible for exploitation. Saudi Arabia occupies over 70% of the Arabian Peninsula, a vast area larger than Western Europe, encompassing a territory of about 2.25 million sq. km. As a result, the issue of accessibility has been prominent on the government's agenda. The European Parsons Brinckerhoff has completed a government-sponsored study on the economic viability of developing a railway network, including plans for a link between Al- Jubail and Ad Dammam on the Arabian Gulf, an east-west land bridge between Jeddah and Ad Dammam, and a link to connect proposed mining sites with Al- Jubail, either via the capital Ar Riyadh, or directly (Saudi Railways Organisation, 1996). The study's positive findings led to a recent review by the World Bank and the Saudi International Bank for possible financing of the cost of the railway which was estimated by SR 1.2 billion. An integrated mining and transportation policy is expected to be unveiled in the first part of 2002.

In a move to enhance its role in the Saudi Arabian economy, the non-oil mineral sector has received more attention from government in the last few years. In fact, the Saudi government has boosted the sector by announcing new plans to promote it. Firstly, the Saudi government announced the formation of the Supreme Petroleum & Mineral Affairs Council (SPMAC). The SPMAC is responsible for

the country's energy policy and will also supervise Saudi Aramco's projects. The SPMAC will also study and endorse general mining policies.

Secondly, in April 1997, the Saudi government established the state-owned Saudi Arabian Mining Company (Ma'aden), which will consolidate all mining projects in which the government is involved. This company is a 100% Saudi governmental holding company with an initial capital of more than SR 3.745 billion reporting directly to MPMR, and the Minister himself is the Chairman of the board. Indications are that shares in the firm will be offered to the public for full or part subscription after it moves to a profitable footing by 2003. The establishment of Ma'aden was the main concrete indication of serious intent by the Saudi Arabian government for a significant expansion in mining activity. Ma'aden is expected to spearhead exploration and mining activities, and has already obtained many licences to mine precious and industrial minerals. Moreover, Ma'aden's major stated activities are to engage in upstream and downstream-related industries, and in increasing the country's gold output in the next few years. Although Ma'aden is state-owned, it does not have a monopoly of the mining sector and operates on a commercial basis, along the model of SABIC, the country's world-class petrochemical company.

Moreover, Ma'aden is expected to be a catalyst for private sector investment. It is presently accomplishing this through direct investment in the development of the mining sector, as well as through joint ventures with private investors. Ma'aden will also encourage changes in mining legislation, and more transparency and

streamlining of regulations to stimulate private investment. According to Ma'aden's President, "Ma'aden recognizes the importance of having transparent laws and regulations, and the need to attract international mining expertise. Given the existence of mineral ores in remote areas that lack the necessary services for a potential mining industry, Ma'aden will also contribute to the development of sufficient infrastructure, such as water, electricity, and telecommunications" (Idrees, 2001).

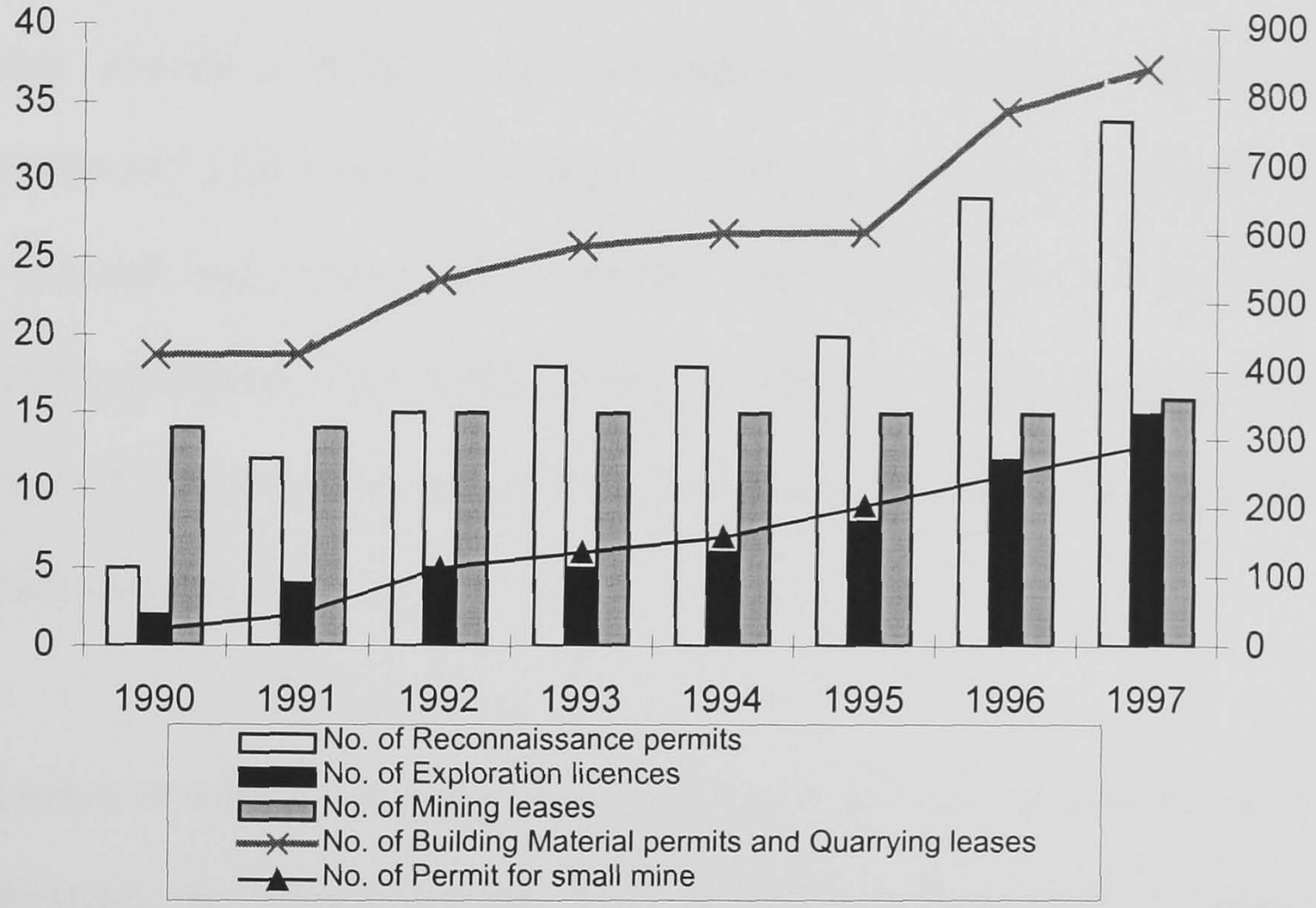
Thirdly, the country's investment laws and regulations have been recently changed and modified. The objective was to encourage private-sector investments in the mining sector, which is expected to grow strongly. The Saudi government views private investment as the engine of growth of the mining sector, and is anticipating more partnerships between local investors and international companies. As for the Mining Code, a multi-day workshop under the auspices of the World Bank was conducted in late October 1999, concerning legal, fiscal, financial and institutional issues to modernise the present Saudi Arabian codes. Should recommendations be implemented, they will impact positively on every aspect of mining business from the issue of exploration licences through to expediting capital project performance; specifically, matters related to land tenure, security and transferability are part of the equation.

Pending completion of the process of promulgating the new Saudi mining code, the government has modified and changed many articles in the existing code to attract foreign investors, for example, granting tax exemption for between five to

ten years, and a 30-year extraction concession. Exploration licences guarantee the exclusive right to explore within the licence area, and the exclusive right to obtain a mining lease. The area granted could be as large as 10,000 sq. km. Exploration leases are initially for five years, and renewable for another four years. Mining leases guarantee the exclusive right to produce and exploit specific minerals in a mining area as large as 50 sq. km. Mining leases are initially for 30 years, and renewable for another 20 years. Mining leases come with a five-year tax exemption. Furthermore, all imported mining equipment is exempt from import and export duties. Foreign investors in the mining sector may repatriate their profits and capital with no restrictions.

The incentives granted to private investors have made investment in this sector highly profitable. According to DMMR annual reports, between 1990 and 1997, the profits of companies that had mineral franchises including sandstone, limestone, and other quarry operations, exceeded SR 11.2 billion. Figure 4.1 illustrates the increasing involvement in mining activities by both local and foreign companies. As a result of the improvement of investment attractiveness, the number of mining deeds and permits awarded increased significantly. For example, the number of valid building material permits and quarrying leases doubled in seven years and reached 841 in 1997.

Figure 4.1: Developments of Mining and Quarrying Valid Deeds and Permits in Saudi Arabia (1990-1997)



Source: DMMR (1998a).

Finally, in October 1999, another important move was the establishment of the Saudi Geological Survey Organisation (SGSO) as an independent entity. The new organisation was to be responsible for geological surveys throughout the country and the efficient dissemination of this information. It has representatives from MPMR, and has a close cooperation with Saudi Arabian national universities and academic institutions, including King Abdul Aziz City for Science and Technology (KACST), a leading research institution in the country. This has enhanced the dissemination of the wealth of information available in their geological database.

4.7 Conclusion

Saudi Arabia is home to the largest non-oil mineral deposits in the region. Non-oil mineral resources are abundant in the form of base and precious metals, as well as industrial minerals. These mineral resources range in size and value from limited potential to deposits large enough to sustain profitable exploitation. Current mining activities, however, are concentrated in building and construction materials and gold mining. Commercial mining is still limited and confined to a few minerals and metals, such as gypsum, silica sand, barite and salt, which can be easily extracted. As a result, the non-oil minerals sector is not an exception among the whole non-oil sector, and even has a relatively lesser role in the Saudi Arabian economy.

In a move to enhance its role in the economy, as well as economic diversification to decrease the reliance on the oil sector, the Saudi Arabian government has announced new plans to promote the non-oil minerals sector. The new plans aim at finding and developing mineral resources, and hence integrating them into the Saudi economy. There are a number of basic chemical compounds available in the country, including acids, phosphates, alum compounds, iron, salt, barium, etc., which can meet a large part of the country's industrial requirements. Saudi industries are using imported minerals, and recycled metals as input raw materials. The new mining projects in Saudi Arabia, however, are expected to meet a large part of these industries' requirements, such as phosphate fertiliser materials, potash, raw materials, and the mineral raw materials such as alumina and iron.

Chapter 5: Saudi Arabian Non-Oil Export Diversification: A Portfolio Approach

5.1 Introduction

The developing countries are highly dependent on export earnings from primary commodities. According to the World Bank (2002), 32-36% of LDCs' export earnings were received from primary commodities in 2000. Commodity prices have always fluctuated, and over many periods tended to decline (Maizels, 1994). As a result, the developing countries' major concerns are both the long-run commodities' price trends and the problem associated with fluctuations in their export earnings.

This chapter will introduce the typical portfolio approach to export diversification, as proposed by Markowitz (1959). Moreover, the marginal portfolio approach (Alwang and Siegel, 1994) will be applied empirically to examine the potential for export diversification to meet the goals of sustained export earnings growth and enhanced stability for Saudi Arabia. The objective for applying this marginal approach is to provide guidance to Saudi Arabian planners who seek simultaneously to increase non-oil export earnings and reduce their instability. Before we apply the approach, we will shed light on the terms of trade between developing and less developed countries, and the variability in short-term commodity prices in terms of the causes and domestic consequences of export instability. The reason behind this is to provide a better understanding of the portfolio approach and its application in export diversification.

5.2 Terms of Trade

It is commonly accepted that trade acted as an engine of growth (as compared with, say, technological change or investment) in the 19th century, at least for the currently developed countries. However, the adequacy of the transmission of economic growth, in recent times, from developed countries to the LDCs has been severely questioned. Some economists argue that in the interaction of developed economies with the primary exporting economies the gains from trade are unequal, and the latter tend to lose relatively more than the former. Prebisch (1950) and Singer (1950) asserted that the economic backwardness of developing countries had arisen from their traditional role as exporters of primary products to the developing economies.

The Prebisch and Singer discussion was based on two distinct hypotheses: short (to medium)-run price instability of exports of the primary producing countries, and the long-run trend in the terms of trade. This section is devoted to explaining the long-run decline of the terms of trade of the developing countries, while the price instability issue will be introduced in the next sections. The most important arguments to explain the long-run decline are the structural differences among these developing countries and the monopolistic forces exercised by developed countries; the average income elasticity of demand for primary goods, which is significantly lower than the average income elasticity of demand for manufactured goods; the increased self-sufficiency of developed areas; and the direction of technical progress which favours the industrialised countries.

The evidence for the proposition that developing countries have faced and will continue to face, long-run decline in their terms of trade is not conclusive either, and there is a danger of over-simplification and over-generalisation. Onitiri (1965) studied empirically the relationships between primary and manufactured goods prices (measured as the ratio of the commodity price index to that of manufactured products). He found five more or less clearly defined phases, corresponding roughly to the following periods: 1) 1800-80, 2) 1880-1913, 3) 1914-38, 4) 1939-52, and 5) 1950-60. Onitiri argued that in the first and fourth phases the terms of trade moved in favour of primary goods, while in the other three this relationship tended to favour manufactured goods. However, there is no agreement about the trend over the period covering all of these phases.

Another important study was carried out by Dantwalla (1965) who measured the terms of trade between developed and developing countries, instead of between manufactured and primary goods, between 1953 and 1960. He argued that some of the primary producing countries are themselves not insignificant importers of primary goods, and some of them, the so-called semi-industrialised, are also expanding their manufacturing exports. The trends in the terms of trade were in favour of developed countries in 1938, and reduced in 1948. In 1951, the trends were reversed in favour of developed countries, then tended to be equal by 1957, and finally the trends moved in favour of developed countries in 1960.

Colman and Nixon (1978) have also shown that in recent years the relationships between primary and manufactured goods appear to be characterised by an

unclear trend. They argued that there is not a well-defined long-run trend, and the short to medium trend of these relationships visible in the statistics is highly sensitive to the initial and final years chosen for comparison. Johnson (1967) has argued that the 1950s were not typical, since they began with a year in which primary commodity prices had been increased suddenly by the Korean war boom, and ended with a year in which prices were drastically reduced by the United States economy and by the new supplies stimulated by the increased prices during the Suez crisis.

Kindelberger and Herrick (1977) mention that developed countries do not export undifferentiated 'primary products', and therefore statements describing trends in the terms of trade in the aggregate do not provide helpful guidance for development policy for any given country's specific situation. A striking example is the experience of oil-producing countries. Colman and Nixon (1978) have also illustrated other primary commodities which account for a high proportion of the exports of a certain number of developing countries, whose prices have over fairly long periods fared relatively well in international trade.

Export instability and its causes and impacts on economic growth have also been of great concern to development economists for many years. However, the issue regarding the impact of export instability on the rate of economic growth has been far from determined. Empirical studies on the relationship between export instability and economic growth have revealed mixed results and findings. The traditional view that export instability has a negative impact on economic growth

was supported by many studies, such as Voivodas (1974), Knudsen and Parnes (1975), Love (1992), and others. They found that export instability has a negative and significant effect on the economic growth rate. Contrary to the traditional view, some studies, such as Caine (1958), MacBean (1966), Moran (1983), and Savvides (1984), have found a positive relationship between export instability and economic growth rate. Other researchers, however, have found no relationship between them, for example Moran (1983) and Kenen and Voivodas (1972). Clearly, this debate over the impact of export instability remains a source of continuing argument.

5.3 Causes of Export Instability

As mentioned above, instability was explained in terms of developing countries' specialisation in the export of primary commodities. Studies suggest that there have been a decline and higher fluctuations in the prices of primary commodities compared to the prices of manufactured products since the early 1970s. Grilli and Yang (1988) found that the commodity terms of trade dropped nearly 40% between 1980 and 1986, compared to a 30% drop between the period of the Great Depression, i.e., between 1929 and 1932.

Numerous researchers have examined empirically the causes and effects of commodity prices and export earnings' trends and instability. They discussed the reasons why primary commodity prices have trended downward, and why increased instability should be expected, following recent changes in international markets. The empirical studies have classified the important factors contributing

to the export instability in the developing countries into two categories: (1) factors contributing to instability in world demand and the relation between world market and elements of instability in individual countries, and (2) factors associated with commodity, trade, and geographic concentration.

In the context of the first category, i.e., causes of world market instability, the majority of empirical analyses suggest that supply factors are the major source of export instability in world market. Many studies were carried out by researchers such as Adler (1958), Brook et al. (1978) and Lord (1981) to investigate the relationship between quantity deviations and price deviations for different commodities. They found that supply disturbance was the major source of instability in world markets for most of the commodities included in the studies. Demand disturbance, however, was found to be the major cause of instability for a few commodities, while both supply and demand were equally responsible in the rest of the commodities in world markets.

The second category, however, has received larger attention in term of studies conducted to investigate the cause of export earning instability. Empirical studies on the causes of export instability have focused on examining three country-specific factors. These factors are (1) dependence on primary products, (2) dependence on one or a few commodities for export, and (3) dependence on one or a few export markets. Despite the evidence of a positive relationship between these three factors and export earnings instability, there has not been a well-established empirical link, in most studies, between export diversity and export

performance (see, for example, Coppock, 1962; Michaely, 1962; Soutar, 1977). Moreover, the widely used measures of export diversity in some of the other studies would not provide practical guidelines for planning changes in a country's export mix.

5.4 Sources and Domestic Consequences of Export Instability

The early literature on the sources and consequences of export instability on LDCs suggested two different views. The conventional view that export instability may negatively affect development plans in developing countries was supported by many studies, such as Nurske (1958), Knudsen and Panes (1975), and many others. These writers argued that the most harmful effect on the domestic economy of developing countries arises mainly from:

(1) Export instability might induce short macroeconomic instability and generate uncertainty in the economy, which in turn affects the supply of savings and investment. Such instability induces higher levels of uncertainty, which in turn increase interest rates, and hence the cost of borrowing. A general increase in commodity prices causes a rise in inflationary expectations which, in turns, leads to higher interest rates to compensate for the expected loss in value of financial assets (Maizels, 1994). In addition, instabilities in the balance of trade may lead to instability in the exchange rate, and then a degree of uncertainty in the future course of the exchange rate. As a consequence, foreign capital and domestic saving may leave the home country in search of more stable foreign investment markets. In other words, uncertainty, in this case, leads to risk-averse behaviour.

(2) Export instability is assumed to reduce import capacity and influence government revenue and expenditure. This is because export earnings are the major determinants of imports for many developing countries, since a sudden reduction in foreign exchange flows impairs import ability. A typical developing country is assumed to depend heavily on imported materials for investment projects. Such projects are sensitive to changes in ability to pay for imports, and may result in damage in the development plans.

The other view, however, is that export instability has a beneficial impact on the domestic economy through three main channels (see, for example, Caine, 1954; Michaely, 1962): (1) uncertainty associated with high-risk high-return projects may encourage risk-loving behaviour, (2) short-term instability may not alter investment decisions; moreover, increased investment in periods of high earnings is partially offset by disinvestments (saving) in periods of low earnings, (3) unstable incomes may tend to increase the recipients' precautionary balances, which increases the marginal propensity to save, which in turn increases the level of investible funds.

Numerous empirical studies have been conducted to investigate the impact of export instability on developing countries (see, for example, MacBean, 1966; Maizels, 1968; Love, 1992). Such studies were generally inconclusive and sometimes even contradictory conclusions were obtained (see Love (1987) for a rich, detailed analysis). Aljerrah (1993) investigated the impact of variations in trade balance on the economy of Saudi Arabia and four other OPEC countries, for

the period 1970-89. He adopted a macroeconometric-simulation approach, consisting of three structural relationships (consumption, imports, and investment, as well as an equilibrium condition). Aljerrah concluded that trade balance variations had negative impacts on the economies of Saudi Arabia and the other four OPEC countries.

5.5 Relationship Between Export Diversification, Export Earnings Growth and Stability

It is believed that a diversified national export portfolio can help lower variability in export proceedings by providing a broader base of exports, and improve growth by substituting commodities with positive price trends for those with negative trends. Growth, in turn, may also be improved by increasing the value added of export commodities through additional processing and marketing, and by substituting imported goods. Although there are potential trade-offs between the growth and stability of export proceedings, diversification cannot be considered a panacea.

The concept of comparative advantage would suggest that a country concentrates on those goods and services in which it holds a comparative advantage, and this could lead to the production of a narrow range of goods and services for export. The diversification of export mix may help to stabilise export earnings, but at the cost of losing the benefits of specialisation. Numerous studies have investigated the impacts of diversification of exports on stability and growth. Most studies found that export diversification by itself will not automatically create either

increased stability or growth. They found that diversification into non-traditional and/or less concentration in commodity exports does not necessarily reduce instability (see, for example, Love, 1983, and MacBean and Nguyen, 1980). Love argued that evidence such as this does not imply that export diversification cannot reduce proceedings' variability, only that in practice it has not done so. He attributed the weak relationships to the fact that export concentration is often associated with concentration in a commodity whose export proceedings (determined by both prices and volumes) are stable, and that countries often diversify into commodities whose proceedings fluctuations are positively correlated with their existing mix.

5.6 Portfolio Theory

Modern portfolio theory provides an approach to financial investment. The theory implies that rational investors will seek efficient portfolios which provide the best risk-return combinations. Therefore, a portfolio is called efficient if it (1) maximises the expected rate of return for a given level of risk, and (2) minimises risk for a given level of expected return. Markowitz (1952) was the pioneer in forming a model of portfolio selection, using diversification principles which laid down the foundation of modern portfolio theory.

In his model, Markowitz assumed that: (1) while investors desire high returns, they are averse to a high variance, e.g. risk, (2) investors base investment decisions regarding risky assets on estimated means, variance, and covariances of rate of returns, (3) investors are considered to be expected utility maximisers

when they make investment decisions. In other words, the utility of an investor is a function of expected return and risk of portfolio. The Markowitz mean-variance portfolio selection model generates the efficient set of portfolios, or as it often called in the portfolio literature, the efficient frontier of risky assets. This could be explained by the fact that, for a given level of expected return, investors are investing exclusively in that portfolio with the smallest risk. Alternatively, for a given amount of risk, only a portfolio with highest expected return will be of interest to investors. In both cases, however, Markowitz assumes that the investor will choose a portfolio that lies in the efficient frontier.

By superimposing a particular set of the investor's indifference curves (utility functions) on the risk/reward region, the investor's optimal portfolio can be found where the highest indifference curve is tangent to the efficient frontier. Though several studies have extended the portfolio theory based on the above model, the Markowitz analysis remains the dominant factor in the area of decision-making regarding risky investments (see, for example, Tobin, 1958; Sharpe, 1964).

5.7 Portfolio Model

As explained earlier, Markowitz showed that for given levels of return, a portfolio could be selected by choosing a share of assets allocated to different investment opportunities in order to minimise risk. By varying the level of returns across the range of feasible returns, holding total assets fixed, and minimising risk at each level, an expected earning/variance (EV) in earnings frontier can be constructed. This EV frontier defines an 'efficient set' of portfolios. An upward sloping EV

frontier implies that increases in earning come at the expense of more variability (instability). The investor can select from this 'efficient set' based on preferences for variability, risk (V), and earnings, returns (E).

Thus, the risk (V) of an export portfolio may be written:

$$v = \sum w_i^2 VAR(P_i X_i) + \sum \sum w_i w_j COV(P_i X_i, P_j X_j) \qquad (1)$$

where,

w_i is non-negative export share of commodity i

P_iX_i is export earning from commodity i

P_i is price

X_i is export quantity (volume)

$VAR\ (P_iX_i)$ is variance of export earnings for commodity i

$COV\ (P_iX_i,P_jX_j)$ is covariance in export earnings from commodities i and j.

Covariances are important for decreasing the risk of earnings' variability. Thus, if export proceedings from commodities i and j are negatively correlated, this covariance lowers the overall variance of the export portfolio. Even if there are no covariances, the share of a stable commodity ($VAR\ (P_iX_i)$ is low) can be increased, and shares of unstable commodities reduced to lower the overall instability. In other words, instability minimisation in the case of no covariation implies complete specialisation in the most stable commodity.

Markowitz begins with a fixed asset base, and shows how the assets can be distributed among N investment alternatives. The Markowitz problem becomes as follows:

Min (V)

Subject to: $M = \Sigma\ P^*_i w_i A$ (2)

$\Sigma w_i = 1 \qquad w_i \geq 0 \qquad i = 1 \ldots\ldots N.$ (3)

where,

$A\ (= \Sigma P_i X_i)$ represents total financial assets,

$$w_i = \frac{P_i X_i}{\sum P_i X_i},$$

P^*_i is expected percentage change in the price of the i^{th} commodity and,

M is expected return from investment.

Most non-oil mineral commodities have followed the same feature of other primary commodities. For many commodities, the non-oil mineral statistics have shown a sharp downtrend in prices and short-term instability (Roskill, 1996). However, the Saudi planners should perceive the non-oil mineral sector as a means of diversification of the export base in order to insulate their country from the downward trends and instability in export earnings. Diversification outside of non-oil minerals (vertical diversification) into exports using non-oil mineral materials as inputs (for example, fertilisers) has long been cited as a means of combating downward price trend and instability for primary commodities (Sapsford and Balasubramanyam, 1994). More recently, there has been interest in increasing diversity within the non-oil mineral sector (horizontal diversification)

by substituting into commodities with favourable and stable price trends, and by exporting commodities whose price instability is negatively correlated with that of the existing export mix.

5.8 Portfolio Model for Export Diversification

Portfolio theory has been widely applied to the analysis of exports. The diversification principle in portfolio theory states that the risk of a portfolio is mainly determined by the interactions among individual investments, rather than by the specific riskiness of each investment. An optimal export portfolio can be created by selecting commodities which together minimise the risk (instability) of export earnings while achieving a given level of export growth rate. Planners seeking to diversify commodity composition of exports of a country can employ this approach to help to maximise and stabilise export earnings.

Many studies have applied export diversification to developing countries to combat downward price trends and instability for primary commodities (see, for example, Prebisch (1951) and Kaldor (1987)). Most of these studies agree that export earnings' instability has more consistently negative impacts on development efforts than does commodity price instability.

Although portfolio theory has been widely applied to the analysis of exports, care must be exercised when applying the Markowitz approach to choose export portfolios. In other words, there are differences between the use of portfolio theory for financial assets and its use in determining export mix. As can be seen

by examining equations (2) and (3), w_i enters both V and the constraints. According to equation (1), the share of total assets, w_i, dedicated to the i^{th} investment opportunity is chosen to minimise V. Therefore, there is a congruence between the w_i, the variation in earnings, and total assets. Thus financial assets can be freely allocated among the N X_is. In contrast, in the case of export earnings, it is less clear how to define A, and hence how to adjust w_i. Exports 'assets' (presumably productive assets used to produce exports) are not very liquid, and the total value of exports is, in reality, determined by the allocation of productive resources among a variety of possible industries. Moreover, this allocation cannot be instantly or costlessly adjusted, substantial lags and significant adjustment cost are likely.

When adjusting, for example, non-oil export earnings, the Saudi planner does not realistically choose from a clearly defined A. For export mixes, A represents total possible export revenues, given the country's total productive resources such as land, labour, capital, etc. Changes in policies designed to adjust export volumes generally result in changes in the allocation of productive resources and, thus, the total value of non-oil exports. The total potential set of feasible export combinations is determined by an export possibilities' frontier (EPF). The EPF, in turn, cannot be known without an investigation of production possibilities combined, given a liberalised domestic market, with an evaluation of domestic demand.

In order to overcome this problem, economists have used a portfolio risk approach to evaluating export earning in different ways. Labys and Lord (1990), and others, create an export share-weighted price portfolio that describes the international price behaviour that a country faces. They use this price portfolio and minimise its variability, subject to different values of an export share-weighted index of export prices. This approach to evaluating export variability came under criticism for some important conceptual weaknesses. Such an approach does not address the issue of how to determine the total amount of assets. The approach, called priced-based portfolio, ignores variabilities in production and export quantities of different commodities. The priced-based portfolio approach contradicts numerous studies that have shown export volume instability to be generally greater than international price instability (see, for example, Glezakos, 1973; Svedbreg, 1991). So if export earnings are to be stabilised, instability of the volumes (quantities) must also be considered. Since there are likely to be covariations, either positive or negative, between export quantities and export prices, both components of export proceedings should be examined simultaneously[5]. The need for including a quantity-based approach in export diversification programmes, however, entails changes in domestic production and trade patterns of commodities.

Some authors have used another way of avoiding the problems of adjusting feasible export volumes from the total asset base by using the portfolio variance

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[5] Under the assumption of low short-run price elasticity of world market supply and demand, one concludes that disturbances caused by demand (supply) factors lead to movement in prices and volumes in the same (opposite) direction.

(equation (1)) solely as a measure of variability (see, for example, Love, 1983). They use portfolio theory to decompose export proceedings to variability by each commodity's contribution to total instability.

This decomposition allows the planner to identify covariances that can lower overall instability. However, this approach also ignores the potential for examining the impact of marginal changes in export quantities. Alwang and Siegel (1994) have modified the standard approach in order to calculate these impacts.

5.9 Marginal Portfolio Approach and its Mechanism

Employing a modified portfolio approach to export proceedings, Alwang and Siegel (1994) examined the potential for export diversification to reduce export variability and maintain export earnings' growth for a group of sub-Saharan African countries over the period 1967-87. As seen above, they argued that the use of portfolio variance in previous studies as a description of instability does not take into account the potential for examining the impact of marginal changes in export quantities. Thus, the problem is not to choose among different commodities' share combinations (commodity share, w_i, is no longer treated as choice variables), but to change the quantities (resources are adjusted to different production activities). The impact of marginal changes in export volumes on variability is given as elasticity by differentiating equation (1) above with respect to w_i

$$\frac{\partial V}{\partial w_i} = 2w_i VAR(P_i X_i) + \sum w_i COV(P_i X_i, P_j X_j) \tag{4}$$

And noting:

$$\frac{\partial V}{\partial w_i} = (1 - w_i)\frac{P_i}{\sum P_j X_j} \tag{5}$$

Combining equations (4) and (5) yields:

$$\frac{\partial V}{\partial w_i} = (1 - w_i)\frac{P_i}{\sum P_j X_j}\left\{2w_i VAR(P_i X_i) + \sum_j w_j COV(P_i X_i, P_j X_j)\right\} \tag{6}$$

which can be computed for each commodity. The marginal change can be converted into an elasticity:

$$\varepsilon_{vi} = \frac{\partial V}{\partial X_i}\frac{X_i}{V} \tag{7}$$

where V is the portfolio variance, X_i is the export volume of commodity i.

The elasticities produced by using equations (6) and (7) can be paired with commodity price growth forecasts or historical growth rates to examine the trade-off between the growth and stability for marginal changes in quantities of exports. In a condition where export possibilities are not well known and stability relationships are variable, then the above marginal approach may be applied. The model can provide guidance about the best changes to make in the short-run, or the best path towards a long-run optimal portfolio. If instability relationships are changing over time, the marginal approach employed here can provide guidance about desirable changes to minimise short-run variability.

The above marginal portfolio model was applied to Saudi Arabia based on the assumptions that:

(1) Commodity composition of Saudi exports is assumed to consist of nine major commodity groups of non-oil exports, which accounted for 96%, on average, of total export receipts (excluding revenues from crude oil[6]) in the period 1984-1995. Three of these nine commodity groups, come under the non-oil minerals, and are classified as: (1) ceramic products, glass, and articles of stone, (2) precious metals and gems, and (3) base metals. The rest of the commodity non-oil exports groups are classified as: (4) foodstuffs, (5) petrochemical products, (6) paper materials, (7) textiles, (8) machinery and electrical equipment, and (9) transport equipment.

(2) World prices are not affected by diversification efforts in Saudi Arabia. That is another reason for excluding crude oil from the model.

5.10 Data Sources

Data on export values in US$, volumes in metric tonnes, and domestic commodity production in metric tonnes, come from commodity trade statistics issued by the United Nations. Export unit values are calculated by dividing export values by volume, which give an f.o.b. unit value US$ per metric tonne. Data on world commodity prices are from publications by the World Bank's International Economics Department, International Commodity Markets Division. Current prices in US$ are converted to real prices in 1987 US$ by using the GNP implicit

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[6] The decision to exclude theoretically and analytically a major commodity, crude oil, precludes any possibility of dominance of one commodity over other commodities in total exports.

price deflator of the US Department of Commerce. Unfortunately, detailed data for Saudi Arabian non-oil exports commodities prior to 1984 do not exist.

As a result, we decided to use the Saudi Arabian non-oil exports between 1984 and 2000. While this period excludes the oil shock in 1973-74 and the subsequent disruption in the world commodity market, it includes both the first and second Gulf Wars, and is a period when drastic declines occurred in most commodity prices.

5.11 Saudi Arabian Non-oil Sector: Exports, Growth, and Stability

The Saudi Economy experienced remarkable changes between 1970 and 1995. Since the first oil price shock in 1973-74, the government expenditure has become the dominant stimulator of economic activity in Saudi Arabia. Such expenditure stimulated domestic investment activity in the non-oil sectors. This policy was further enhanced after the oil price mini-boom in 1979-80 (Al-Hasan, 1997). Thus, any adverse change to oil revenue would affect the growth of non-oil sectors in the economy. The drastic cut in oil prices in 1980s caused a sharp fall in Saudi oil revenue which, in turn, resulted in the first ever, both budget and current account deficit, in 1983. These deficits kept on growing in subsequent years, in which the budget deficit reached the unprecedented level of SR 98.7 billion in 1991.

The Saudi Arabian government has recognised the fact that dependence on a single product, namely crude oil, as the main source of income would not be a

successful economic policy. In order to sustain economic growth, the Saudi Arabian main policies are to strengthen the role of the private sector and to diversify the economy away from the oil sector. This objective has received great attention from all levels of the Saudi Arabian government officials, and became a national priority. Although the Saudi Arabian government's dependence on oil has declined in recent years due to large revenue generated from increasing prices of its basic services to the public (by cutting subsidies), and selling more of its export-oriented products (mainly petrochemicals and non-oil mineral products), unfavourable changes in the oil economy would have a considerable impact on much of the economic activity in the domestic non-oil economy, particularly the private sector. This has been the case in the past two decades, and will continue at least in the near future.

Nevertheless, the Saudi Arabian government diversification effort during the past two decades has resulted in a substantial decline in the relative role of oil exports. Non-oil GDP increased more than fourfold, with a real average annual growth of 6%. The value added by the non-oil sector as a share of GDP increased from 53% in 1970 to 67% by the year 1995. The contribution of non-oil revenues to total government revenues increased from 9% in 1970 to 28% in 1995. Non-oil exports increased from 8% in 1970 to about 21% by the year 1995. Despite the fact that the Saudi planners have succeeded, to some extent, in diversifying the export base over the past five Development Plans, 1970-1995, they are still concerned with the problem of instability of earnings.

The role of the non-oil sector in total exports is illustrated in Table 5.1. Non-oil export slightly increased its share of total export earnings over the two periods examined, even though non-oil export earnings were stagnant in the second period. Stagnant non-oil export earnings were accompanied by increasing export shares, indicating poor performance for the entire non-oil export sector. Export earnings' instability, however, fell relatively across the two periods[7]. In the subsequent section, we examine how the portfolio approach could be applied to reduce export instability.

Table 5.1: Saudi Arabian Non-Oil Export Earnings (1984-1990 and 1991-2000)

Year	Average Value (SR million)	Share in total export earnings (%)	Growth rate in real export earnings (% per year)	Coefficient of variation
1984-1990	6081.66	19.9	2.06	13.19
1991-2000	17782.91	26.6	0.05	5.38

Source: Author's calculations based on SAMA (1998).

5.12 Analysis of Results

The analysis focuses on two distinct periods, 1984-1990 and 1991-2000. The break in 1990 corresponds to the oil price shock when Kuwait was invaded by Iraq, believed to have caused subsequent disruption in world commodity markets. Table 5.2 below illustrates the trade-offs between growth and stability in export earnings. ε_{vi}, or column (1) shows the elasticity of the portfolio variance (V) (see

[7] Coefficient of variation as a measure of variability is predicted on the assumption that the time series of export earnings is stationary along deterministic trend.

equation (1)) with respect to change in export volume for each commodity. The commodities are ranked according to these elasticities in column (2).

Table 5.2: Elasticities of portfolio variance, percentage change in export earnings, and price trends by commodity groups (1984-1990 and 1991-2000)

1984-1990						
Commodity Group		ε_{vi}		W_i[1]	World Price Trends US$	
		Stability (1)	Ranking[2] (2)	(3)	% Change (4)	Ranking[b] (5)
Non-oil Mineral	1	0.32	7	0.01	0.6	3
	2	-0.09	5	0.01	0.3	4
	3	-0.56	4	0.09	-0.1	5
Other Non-oil	4	2.85	8	0.10	-0.7	8
	5	-4.64	1	0.61	-0.5	7
	6	3.51	9	0.03	-4.2	9
	7	0.29	6	0.02	-0.2	6
	8	-2.50	2	0.07	5.5	1
	9	-1.10	3	0.08	3.2	2
1991-2000						
Non-oil Mineral	1	0.57	5	0.1	-0.2	3
	2	0.28	4	0.1	-1.5	6
	3	1.76	6	0.8	-0.6	4
Other Non-oil	4	6.34	8	0.10	-1.2	5
	5	3.42	7	0.58	-10.1	8
	6	8.15	9	0.02	-15.7	9
	7	0.0	3	0.02	-3.3	7
	8	-4.53	1	0.08	2.9	1
	9	-2.51	2	0.10	1.7	2

ε_{vi} is calculated as equation (7).

[1]Because it is the share of the commodity in total non-oil exports, W_i represents the percentage change in export earnings given a 1% increase in quantity of the i^{th} good.

[2]Rankings are from 1 (= best outcome) to 9 (= worst outcome).

Source: Based on author's calculations.

During 1984-90, a 1% increase in the volume of ceramics (commodity no.1) exported would have increased Saudi Arabian overall export variance by 0.32%. Similarly, a 1% increase in volume in foodstuffs, paper materials and textiles

would also have increased Saudi Arabian earnings' instability by 2.85%, 3.51% and 0.29%, respectively. Increases in the volumes of precious metals, base metals, petrochemicals, machinery and transport equipment, however, would have lowered Saudi Arabian overall export variance by 0.09%, 0.56%, 4.64%, 2.5% and 1.1%, respectively.

To place these elasticities in perspective, however, the percentage change in export earnings associated with a 1% increase in the volume of each commodity is shown in column (3) in Table 5.2. Petrochemical products, because they comprise a large share of Saudi Arabian non-oil exports, are associated with the greatest percentage increases in export earnings. Therefore, a 1% increase in petrochemical goods would increase total non-oil export earnings by 0.61% during 1984-1990. A 1% increase in volume in machinery and electrical equipments volume, although it would reduce export earnings' stability, would however increase total non-oil exports by only 0.07% during the same period.

Changes in international markets' commodity prices affect the expected earnings from a change in export portfolio; the historical price changes and their rankings are shown in columns 4 and 5, respectively. A comparison of the rankings in columns 2 and 5 shows that there is a link (trade-offs) between earnings growth and earnings stability for Saudi Arabia. Petrochemical products, for example, ranked high in terms of stability enhancement, but are ranked relatively low in terms of price changes, as the real market price of petrochemicals declined by 0.5% per year in 1984-1990. This decline was due to the world surplus of

production capacity in some basic petrochemicals. Moreover, Saudi petrochemicals' exports were facing the problem of the continuation of customs barriers over the past decade in some markets, particularly the European ones.

Depending on the preferences of Saudi Arabian policy-makers for stability and growth, Table 5.2 can be used to determine which commodities' export quantities should be increased and which decreased. For example, ceramics is relatively destabilising, but its market prices have shown consistent growth among Saudi Arabian non-oil exports. Precious metal commodities are moderately stability enhancing, and also show a reasonable price-trend ranking. On the other hand, increased dependence on export of paper materials is clearly undesirable, due to both their high level of instability and negative price trends.

The 1991-2000 period results show that many of the stability rankings changed from the first to the second period. The relatively higher portfolio variance elasticities in the second period are caused by decrease in overall instability from the first to the second period[8]. A comparison across the two periods in Table 5.2 reveals some of the dangers in trying to reduce variability by making adjustments in export quantities. If, for example, the Saudi Arabian government placed heavy emphasis on stability, then the first period suggests that petrochemicals' exports created much more instability than did exports of either machinery, transport equipments or textiles. At the same time, petrochemicals prices fell by a greater

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[8] Note that the elasticities uses the value of the portfolio variance, V, as the base.

percentage in the second period than in the first. An increase in petrochemicals products' share between the first and second periods would have increased export earnings' variability and led to relatively less earnings' growth for Saudi Arabia.

Had Saudi Arabian planners decided that earnings growth rather than instability was important, and had they relied on historical trends to forecast future growth, at the end of the first period they might have decided to increase exports of ceramic commodity.

Although Table 5.2 shows that there are fewer trade-offs between stability and earnings growth, the choice of the 'best' export portfolio is clear for Saudi Arabian planners. During both periods, international price trends for both machinery and transport equipment and the impact of their exports on earning stability (as measured by $\varepsilon_{machinery}$ and $\varepsilon_{transport}$) were ranked best. Outside machinery and transport commodities, however, there are fewer examples of commodities that rank favourably in terms of both price trends and stability, or in terms of consistency across the two periods.

Finally, Table 5.2 shows that there is inconsistency in the impacts of change in the commodity quantity on stability and earnings' growth from period to period. The commodities' impact on instability or earnings changed dramatically from one period to the next. Thus, the design of 'optimal' adjustments in the export portfolio is complicated. If it may be assumed that price trends can be forecasted more accurately than proceedings instability, then it is wiser to choose changes in

the export portfolio based on expected proceedings. Decisions regarding production adjustments should also include analyses of domestic production possibilities and resource costs, etc..

5.13 Conclusion

Dependence on export earnings from a narrow base of commodities has created pressures on LDCs to diversify their export base. This chapter examines the potential for export diversification to meet the goals of sustained export earnings growth and enhanced stability for Saudi Arabia.

Conditions in international markets are such that prices of many primary commodities have been declining at the same time as there has been increased price instability. As far as we are concerned with the non-oil mineral commodities, ceramics and glass showed relatively slower prices trends than base metals and precious metals. However, precious metals came as the best of the non-oil mineral commodities in terms of stabilising the Saudi Arabian exports, followed by base metals, and finally by ceramics and glass.

It was shown that the portfolio approach could assist in designing diversification programmes that enhance performance. The analysis showed that Saudi Arabian planners could make changes in their non-oil export earnings' growth and stability. Increasing both machinery and transport equipment, for example, would have met growth and stability goals in 1991-2000.

The optimal distribution of export proceedings can still not be determined without investigating production possibilities, the cost factors, the market access, along with adjustment costs needed to achieve the new optimal export mix. The above portfolio approach, however, does not take account of the components incorporated in each of the Saudi Arabian non-oil export commodities. Saudi Arabian planners should calculate the ratio of total imports required to produce output for each of the commodities (industries). Using input-output in the next chapter, we are going to calculate the import content of exports in each Saudi industry.

Chapter 6: Linkage and Multiplier Effects of Saudi Arabian Non-Oil Minerals Sector: An Input-Output Approach

6.1 Introduction

We have seen in Chapter 3 that within the balanced development strategy following the decline in oil price in the 1980s, more emphasis was put on the non-oil sector, especially on the manufacturing, and agriculture sectors and more recently, the non-oil minerals sector, in order to diversify the economy away from oil. These non-oil sectors were considered as the engine of the Saudi Arabian economic development which could contribute to the creation of an integrated economy. Indeed, it was believed by the Saudi Arabian policy-makers that these sectors (industries) were able to induce further investments both in upstream and downstream industries through backward and forward linkages. The Fourth Development Plan (1985) defined diversification as transforming the economy from a country of comprehensive dependence on oil to one of diversified industrial and agriculture production. It was necessary to select those industries most suitable to the country, in terms of a comparative advantage, and that had a strong backward and forward linkage to the domestic economy (Nazar, 1985).

Unfortunately, however, the identification of key (leading) sectors was made arbitrarily by the Saudi Arabian policy-makers, and without any prior empirical investigation to see whether any chosen sector could actually develop backward and forward linkages with other sectors. The question of whether the sectors that were chosen by the Saudi Arabian policy-makers as leading sectors (with more

emphasis on the non-oil minerals sector) have contributed fairly well to the inter-sectoral integration of the Saudi Arabian economy can be investigated empirically. The empirical investigation will, moreover, identify the leading sector in the Saudi Arabian economy on the basis of the linkage and multiplier effects. Accordingly, a judgement will be made on the selection of leading sector(s) by the Saudi Arabian policy-makers.

Therefore, in the present chapter, we are going to apply the input-output model to evaluate and estimate two measures of the effects of diversification. Firstly, the sectoral economic multipliers, namely the output multipliers, the income multipliers, the employment multipliers, and the foreign exchange earnings and savings multipliers generated by the non-oil minerals sector and the other sectors of the economy. The purpose is to find out which sectors could satisfy our policy objective. Secondly, the inter-sectoral linkages between sectors, with more emphasis on the inter-sectoral linkages of the non-oil minerals sector with the rest of the economy.

For this purpose, we have used the recent Saudi Arabian input-output table which was constructed on 1994.

6.2 Input-Output Model

An input-output table is a way of recording the flow of goods and services between the different sectors of a national economy during a particular period of time. It classifies each flow by its origin and by its destination. A flow can be

classified by its origin as coming from one of the sectors of production in the national economy, such as manufacturing, agriculture, etc., or as being based on a factors of production, such as imports, wages and salaries. By its destination, a good can be classified as being delivered to one of the sectors of production, or as being part of the final demand categories, such as consumption, export, investment, etc.. Each flow is registered only once at the interaction of the column, which represents the sector from which the flow leaves, and the row, which stands for the sector into which it enters. The rows and columns of the input-output table correspond to the debit and credit sides, respectively, of the sectors. The row and column totals for any particular sector must be equal.

This calculation can be represented mathematically by a set of simultaneous linear equations such as:

$$x_i = \sum_{j=1}^{n} X_{ij} + f_i \left(i = 1,2,3.....n\right) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

where x_i stands for the gross output of the ith industry, while X_{ij} is the product of the ith industry used as input by the jth industry, and f_i is the output of industry i available to final demand. This equation is termed a balance equation, which means that the gross product of a commodity is equal to the quantity used as intermediate product plus that in final goods, which can be consumed, invested or sold abroad.

It is assumed that there is a linear production requirement summarised by

$$X_{ij} = a_{ij} X_j$$

which can be written as the following input-output coefficient: $a_{ij} = \dfrac{X_{ij}}{X_j}$

If we denote this term by a_{ij}, then we can rewrite equation (1) as:

$$x_i = \sum_{j=1}^{n} a_{ij} X_j + f_i \left(i = 1,2,3.....n\right) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

This equation constitutes the fundamental relationship of the input-output system.

To explain such relationships further, it could be useful to represent the above system in schematic form:

Output

	Industry	1		2		3.....n			f	x_i
Input	1	X_1	+	X_{13}	+	X_{13}	+	X_{1n}	f_1	x_1
	2	X_{21}	+	X_{23}	+	X_{23}	+	X_{2n}	f_2	x_2
	3	X_{31}	+	X_{33}	+	X_{33}	+	X_{3n}	f_3	x_3
	N	X_{n1}	+	X_{n3}	+	X_{n3}	+	X_{nn}	f_4	x_n

In this form, the total of the inter-industry demand f_i, as mentioned before, represents the gross output of industry x_i. The column, on the other hand, represents the intermediate input required by the industry denoted by the column to produce its output. Entries in the column represent the structure of that input by dividing each entry (cell) of the given industry column by its output. We obtain the input coefficients of product in that industry i.e. $\frac{X_{13}}{X_3} = a_{13}$, which is the input proportion of industry (1) products required for industry (3) as an input to produce one unit of its output. By a similar treatment of all entries, we can obtain a table of coefficients such as: $A = \begin{bmatrix} a_{11} & a_{12} & a_{13}....a_{1n} \\ a_{21} & a_{22} & a_{23}....a_{2n} \\ a_{31} & a_{32} & a_{33}....a_{3n} \\ . & . & . \\ . & . & . \\ . & . & . \\ a_{n1} & a_{n2} & a_{n3}....a_{nn} \end{bmatrix}$

This is usually called the structural matrix of the economy. If that matrix is denoted by the letter *A*, then an input-output system in matrix form can be written as:

$$x = AX + f \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

where *x* is total output n x l column vector. *A* is an n x n coefficients matrix, and *f* is final demand n x 1 vectors. It is obvious from the above that once we have the matrix *A* and the total output vector *x*, we can easily obtain the value of *f*. By the same token, when matrix *A* and vector *f* are given, then one can solve for *X*. Thus, from (3) above, we can obtain:

$$f = x - AX \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

Or $$f = X(I - A) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

Therefore $$x = (I - A)^{-1} f \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (6)$$

The symbols *f*, *x*, and *A* denote quantity available to final demand, gross output, and input coefficients matrix as before. (I), on the other hand, represents an identity matrix, all elements of which are zero, except those cells on the diagonal, which have a value of one. The term $(I-A)^{-1}$ is called the 'Leontief Inverse Matrix'. This matrix plays an important role in input-output analysis. Once such a matrix has been found, an equilibrium level and composition of output to satisfy a given level of final demand can be calculated, assuming that the economy was in equilibrium when the input-output table was estimated. Such an assumption means that there is a full adjustment of the use of inputs to the composition of final demand.

However, since the static input-output model normally encompasses a large number of industries, its framework is of necessity rather involved. To simplify the problem, the following assumptions are as a rule adopted:

(1) Homogeneity: each sector in the input-output table produces only one single output with a single input structure, and there is no technical substitution between the outputs of different sectors. The homogeneity assumption means that when the *j*th final demand increases, only the *j*th sector's output is affected in the first instance. This will only be satisfied if there are no joint products (between sectors), so that the principal product of the *j*th sector must not be produced elsewhere, as either a secondary or a by-product.

(2) Production in every sector is subject to constant returns to scale and technical progress is absent, i.e., the production function is assumed to be linear.

(3) Each sector uses a fixed input ratio for the production of its output, i.e., the technical coefficients are fixed, which means that there is no substitutability between inputs. This assumption stems from the fact that the input-output model is effectively isolated from such external economies by the absence of price effects. Accordingly, the impact of capacity expansion in a sector, say *i*, on the output of a sector *j*, such that the output of *j*th sector uses as input the *i*th output, via the change in the price of *i*th input, is ignored in the input-output model.

Although these assumptions are open to criticism, they enable a one-to-one correspondence between sectors and product, besides rendering the model

analytically manageable[9]. As far as we are concerned, these assumptions are quite valid because we are intending to use an static input-output model to estimate the linkage and multiplier impacts of the different economic sectors during a particular period of time. In other words, these assumptions may be violated in the case of forecasting, which is not involved here.

6.3 Saudi Arabian Input-Output Table

The latest published Saudi Arabian input-output table relates to 1994. The construction of the table, produced by the Ministry of Planning, was based on the data from various government sources. The table consists of 10 production sectors, 6 components of final demand, and 6 primary inputs.

The input-output for the Saudi Arabian economy, given in Appendix C, can be regarded as falling into four quadrants (matrices). The first matrix consists of 10 rows and 10 columns, one for each production sector in the economy and represents the intermediate transactions among the ten sectors. As the sectors in the rows are the same as those in the columns, this quadrant is square. The 10 major sectors are as follows:

No.	Industry
1	Agriculture, Forestry and Fishing
2	Oil Production & Refining
3	Non-Oil Minerals
4	Manufacturing Industry

[9] Many writers have investigated the effect of these assumptions, such as Koopman (1951) and Bulmer-Thomas (1982).

5 Electricity, Gas and Water

6 Construction

7 Commerce, Restaurants and Hotels

8 Transport, Communication and Storage

9 Finance, Insurance and Banking

10 Services

The second quadrant consists of purchases of commodities by the main categories of final demand. These comprise labour, capital (fixed capital consumption), households (private consumption expenditure), government expenditure, institutions (gross fixed capital formation and change in stock), and exports. This gives a 10 x 6 matrix. The third consists of entries representing purchases of primary inputs into production sectors. These are labour income (wages and salaries), capital income, household income, government income, institutions, and imports. Thus it is a 6 x 10 matrix. Finally, the fourth quadrant represents entries of primary input used by final demand categories, i.e., a 6 x 6 matrix.

Like most developing countries, Saudi Arabia does not produce an input-output table frequently. The latest official Saudi Arabian input-output table, constructed by survey, was produced in 1977. Due to the time and expense required to construct a new table, the Ministry of Planning decided to establish the 1994 input-output table by using existing official data. The household income (row) has been assumed by the Ministry of Planning to come entirely from the earnings of the two factors, labour and capital.

The Saudi Arabian input-output table highlights some features of its economy. The cell entries in the sectors' matrix table vary between zero and relatively high values. The higher the values, the greater are the inter-sectoral linkages, and vice versa. Another feature is the domination of the manufacturing and oil sectors in the economy, which respectively account for 32% and 22% of the total industry output. The importance of the oil and petrochemical industries becomes apparent. Agriculture, non-oil minerals, and manufacturing sectors are the major importing sectors of the economy (SR 13,786.5 million, SR 5,055.4 million, and SR 108,039.9 million, respectively). Import figures for the seven remaining sectors have been shown as imports of the capital and households sectors.

6.4 Multiplier Effects

The most important characteristic of the Leontief inverse matrix is that it is vital for the impact analysis of a given change in final demand on the different constituents of the economy. To see how this is the case, let us go back to the solution of the input-output system, which appears as $x = (I-A)^{-1}f$. Further, let $Z = [z_{ij}]$ represent the inverse matrix $(I-A)^{-1}$, then the solution to the equation above can be written as $x = Zf$.

In matrix form, this will be:

$$\begin{bmatrix} x_1 \\ x_2 \\ x_3 \\ . \\ . \\ . \\ x_n \end{bmatrix} = \begin{bmatrix} z_{11}f_1 & z_{12}f_2 & z_{13}f_3 \ldots\ldots z_{1n}f_n \\ z_{21}f_1 & z_{22}f_2 & z_{23}f_3 \ldots\ldots z_{2n}f_n \\ z_{31}f_1 & z_{32}f_2 & z_{33}f_3 \ldots\ldots z_{3n}f_n \\ . & . & . \\ . & . & . \\ . & . & . \\ z_{n1}f_1 & z_{n2}f_2 & z_3f_3 \ldots\ldots z_{nn}f_n \end{bmatrix}$$

The general answer to what will be the rate of change in x with respect to a change in final demand f can be found by partially differentiating the value of x with respect to f, i.e.

$$\frac{dxj}{df_i} = z_{ij}\left(j, i = 1,2,3.....n\right)$$

By carrying out the differentiation process for all terms in the system, the original matrix *(Z)* will be obtained (which is the inverse matrix). This indicates the importance of this matrix as a tool for economic planning through which the direct and indirect impact of a given change in one or more final demand constituents on the different sectors of the economy's activities can be ascertained, and consequently its impact on the economy as a whole.

It is useful to measure multiplier effects to identify the sectors of the economy which can fulfil certain policy objectives. The policy objectives in which we are interested are output growth, exports' maximisation, imports' minimisation, income maximisation, and employment generation. These policy objectives are captured, respectively, by the following economic multipliers: the output multipliers, export multipliers, import multipliers, income multipliers, and the employment multipliers.

6.4.1 Output Multipliers

Let $Z = (I\text{-}A)^{-1} = (z_{ij})$.

The matrix Z is termed the matrix of interdependence coefficients. Each element z_{ij} indicates the total (direct and indirect) requirements from sector i arising from

increase in sales of one unit, say one Saudi Arabian riyal, to final demand by sector *j*. The *Z* matrix therefore provides extremely important structural information relating to the economy under study, by indicating the strength of inter-sectoral economic linkages.

The coefficients z_{ij} indicate the extent to which changes in the level of activity of one sector will affect, directly or indirectly, the level of output of all other sectors. Each element z_{ij} shows the direct and indirect effects on the output of each sector from an increase in sales of one riyal to final demand by sector *j*. It follows that the $\sum_i z_{ij}$, or the column sums of the inverse of the open model, will show the total effect on all sectors in the table (i.e., the total output effect on the local economy), of an increase in sales of one riyal by sector *j* to final demand. For this reason, $\sum_i z_{ij}$ is termed the 'simple output multiplier'.

When the model is closed with respect to households, i.e., the household rows are included in the processing sector, the inverse $Z^* = \left[z_{ij}^*\right] = (I - A^*)^{-1}$ may be obtained, where each element z^*_{ij} provides, in the non-household rows of the inverse, the effect (direct, indirect and induced) on the output of each sector of increases in sales to final demands by sector *j*. The column sum of the non-household z^*_{ij} provides a measure of the total output multiplier for each sector. Hence, it is possible to distinguish three effects in the output multiplier:

(1) Direct effect. This is shown by the direct coefficients a_{ij}, and represents the immediate or first round effects on each sector of an increase in output of sector j.

(2) Indirect effect. This is shown, together with the direct effect in the z_{ij}, or elements of the inverse of the open model, and represents the second and subsequent round industrial support requirements from each sector, following an increase in sales to final demand of any sector. The indirect effect for any sector can be calculated simply as $z_{ij} - a_{ij}$.

(3) Induced effect. This is shown, together with the direct and indirect effects, in the non-household rows of z^*_{ij}, or elements of the inverse of the closed model, and represents the effect on the output of each sector occasioned by increased household consumption as a result of increased sales to final demand of any sector. The induced effect for any sector can be calculated simply as $z^*_{ij} - z_{ij}$.

The facility to disaggregate multipliers into direct, indirect and induced effect is an important advantage of the input-output approach, in that the different components of an impact may be recognised and compared. This facility is applicable also to both income and employment multipliers.

In Table 6.1 below, two types of multipliers were calculated, namely the simple output multiplier, as a summation of the columns of the inverse of the closed model in Table B.2, and the total output multiplier, as the summation of the non-household row of the inverse of the closed model[10]. The simple output multiplier

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[10] All calculations involved in this chapter and the next chapter were performed using 'MATHCAD' software.

for sector *j* indicates the direct and indirect industrial support requirements from all sectors required for each increase of one unit in sales of the output of sector *j* to final demand. For example, each increase in the sale of the output of the non-oil mineral sector to final demand requires a total increase of SR 1.113 from the rest of the sectors in the economy. The additional SR 1.113 required is in the form of industrial support from other sectors; the disaggregation of these requirements by sector can be gained from the inverse of the open model.

Table 6.1: Output Multipliers

Sector	Direct & Indirect	Rank	Total	Rank
Agriculture, Forestry and Fishing	1.095	9	1.140	7
Oil Production & Refining	1.044	10	1.055	10
Non-Oil Minerals	1.113	7	1.119	9
Manufacturing Industry	1.112	8	1.137	8
Electricity, Gas and Water	1.563	2	1.643	3
Construction	1.528	3	1.668	2
Commerce, Restaurants and Hotels	1.283	4	1.397	4
Transport, Communication and Storage	1.196	5	1.303	5
Finance, Insurance and Banking	1.151	6	1.301	6
Services	1.732	1	2.0	1
Average	1.282		1.376	

Source: Author's calculations based on 1994 input-output table.

The total output multiplier for sector *j* measures direct, indirect and induced requirements for all sectors, for each riyal increase of sales of sector *j* to final demand. In addition to the components of the simple output multiplier, it therefore includes the induced effect, or that increase in output from the sector occasioned by increased household income as a result of the increase in sales to final demand. For example, an increase of one riyal in the sale of the output of the non-oil minerals sector produces a total increase in output of SR 1.119. The induced effect of the increased sales will therefore be only SR 0.006.

An examination of Table 6.1 above provides some important information with respect to the expected output response of each sector in the economy. This may be summarised as follows. First, similarities, to a great extent, which occur in the rankings of both multipliers. Secondly, the output multipliers of services, constructions, and electricity are the largest among the sectors. This draws attention to the importance of these sectors as leading components of the Saudi Arabian economy. Finally, the low Saudi Arabian figures are due to the relatively open nature of the economy, imports amounting to about 30% of GNP. Saudi Arabia is the largest import market in the region and one of the top 15 importers in the world. In 1999, the country is estimated to have imported around US$ 29 billion worth of goods (United Nations, 2000). This level of imports causes severe leakage from the system, resulting in relatively low multipliers for many sectors which depend heavily on imported raw materials.

The smallest output multipliers amongst all sectors, when the induced effect is included, are for the oil sector, followed by the non-oil mineral sector. This was expected, as the oil sector is an enclave sector. Clearly, the low output multiplier of the non-oil mineral sector reflects its insignificant importance in the Saudi Arabian economy in 1994.

6.4.2 Export Multipliers

The sectoral exports multipliers are obtained by dividing exports of each sector by the total output of the same sector.

$$XM_i = \sum_{i=1}^{n} E_i / x_i$$

The export multipliers indicate the increase in total exports or foreign exchange earnings in the whole economy, when final demand in sector *j* increases by one unit. The purpose of calculating the exports' multiplier is to measure the role played by the non-oil minerals sector and the other sectors in providing the economy with foreign earnings. This measure will in turn be used as a basis for making sectoral assessment with respect to the maximisation of exports, which is one of our proposed policy objectives.

Table 6.2: Export Multipliers

Sector	Exports Impact	Rank
Agriculture, Forestry and Fishing	0.001	8
Oil Production & Refining	0.462	1
Non-Oil Minerals	0.022	3
Manufacturing Industry	0.002	7
Electricity, Gas and Water	0.0	10
Construction	0.0	9
Commerce, Restaurants and Hotels	0.004	5
Transport, Communication and Storage	0.033	2
Finance, Insurance and Banking	0.003	6
Services	0.016	4
Average	0.054	-

Source: Author's calculations based on 1994 input-output table.

From Table 6.2, the export multiplier of the oil sector, as expected, is large due to the fact that a very large proportion of its final demand is in the form of exports. The low effects of the other sectors' multipliers reflect the domination of oil as the main source of foreign earnings. However, the non-oil mineral sector shows that an increase in final demand by one riyal will contribute SR 0.022 to the Saudi Arabian economy.

6.4.3 Import Multipliers

The impact on imports can be estimated by finding the import contents of output required to satisfy one unit of change in final demand. In order to do so, however, it is necessary to net out the import content from the total coefficient matrix, since imports represent leakages from the incremental inter-industry flow generated by such expansion in final demand. For this purpose, the following model is used:

$M = M_j\ (I\text{-}A)^{-1}$

where:

M = Row vector of import requirements of a given one unit increase in final demand.

M_j = Row vector of import coefficient in the Table B.3.

$(I\text{-}A)^{-1}$ = Inverse of total coefficient matrix.

The expression $M_j\ (I\text{-}A)^{-1}$ represents the direct and indirect sectoral import required to produce one unit of demand for products of that sector. To incorporate the induced impact on import requirements, the Z^* matrix will again be used.

The net effect on domestic output can be found by subtracting the above result from the original $(I\text{-}A)^{-1}$, i.e.:

$(I\text{-}A)^{-1} - M\ (I\text{-}A)^{-1}$

or let

$(I\text{-}A)^{-1} = z_{ij}$ *and* $M_j\ (I\text{-}A)^{-1} = M_{ij}$

therefore: $\sum D_{ij} = \sum z_{ij} - \sum M_{ij}$

The solution for these equations is given in Table 6.3. The table shows that for every one riyal of increase in final demand, the direct and indirect import content needed as a result of one riyal unit increase in demand for non-oil mineral is equal to SR 0.44. This will reduced to SR 0.37 when induced effects are incorporated, i.e., Type II.

Table 6.3: Import Impact and Net Impact on Domestic Gross Output

Sector	Total Impact		Import Leakages (Impact)		Net Effect on Domestic Impact	
	TYPE I[1]	TYPE II[2]	TYPE I	TYPE II	TYPE I	TYPE II
Agriculture, Forestry and Fishing	1.095	1.14	0.633	0.453	0.462	0.687
Oil Production & Refining	1.044	1.055	0.043	0.021	1.001	1.034
Non-Oil Minerals	1.113	1.119	0.440	0.370	0.673	0.749
Manufacturing Industry	1.112	1.137	0.564	0.190	0.548	0.947
Electricity, Gas and Water	1.563	1.643	0.001	0.001	1.562	1.642
Construction	1.528	1.668	0.004	0.002	1.524	1.666
Commerce, Restaurants and Hotels	1.283	1.397	0.001	0.001	1.282	1.396
Transport, Communication and Storage	1.196	1.303	0.002	0.003	1.194	1.300
Finance, Insurance and Banking	1.151	1.301	0.001	0.001	1.151	1.300
Services	1.732	2	0.001	0.002	1.731	1.998
Average	1.282	1.376	0.169	0.098	1.113	1.272

[1] Direct and Indirect Effect.
[2] Direct, Indirect and Induced Effect.
Source: Author's calculation based on 1994 input-output table.

Clearly, in terms of high import content, the non-oil minerals sector comes third, directly after the agriculture and manufacturing sectors. The identification of the content of imports could be valuable information to Saudi Arabian policy-makers. The planners can derive the appropriate policy for import substitutions.

6.4.4 Analysis of Multipliers' Results

Table 6.4 shows the sectoral output multipliers, sectoral export multipliers, and sectoral import multipliers with their rankings, for the Saudi Arabian economy in 1994. Sectors are ranked by values of their multiplier indices, so that those with the largest indices come first. However, imports' multipliers are treated differently, in the sense that sectors with lower than average imports' multipliers are to be lesser in terms of leakages. The sectors are therefore ranked by the size of their imports' multipliers, with the smallest indices coming first.

Table 6.4 shows that the top five sectors, as far as output multipliers are concerned, were sectors 10, 6, 5, 7, and 8. In terms of exports' multipliers, the table reveals that the top five sectors were sectors 2, 8, 3, 10 and 4. The top five sectors according to the import multipliers criterion were sectors 9, 10, 7, 5 and 8. It is obvious that only sectors 8 and 10 (Transport, communication and storage, and Services) ranked within the top five sectors in terms of all three economic multipliers. The non-oil minerals sector was ranked third on the exports multiplier, and failed to be ranked in the top half, in terms of both output and imports multipliers. On the other hand, the oil sector had the highest index for the exports multiplier, which indicates the important contribution of the sector in providing the Saudi Arabian economy with the necessary foreign exchange earnings. In the meantime, the sector had high leakages into imports, which means that the sector was using inputs which were not produced domestically.

Table 6.4: Sectoral Multipliers and Ranks

Sector		Output Multiplier	Rank	Exports' Multiplier	Rank	Imports' Multiplier	Rank
1	Agriculture, Forestry and Fishing	1.140	7	0.001	8	0.633	10
2	Oil Production & Refining	1.055	10	0.462	1	0.043	7
3	Non-Oil Minerals	1.119	9	0.022	3	0.440	8
4	Manufacturing Industry	1.137	8	0.002	7	0.564	9
5	Electricity, Gas and Water	1.643	3	0.0	10	0.001	4
6	Construction	1.668	2	0.0	9	0.004	6
7	Commerce, Restaurants and Hotels	1.397	4	0.004	5	0.001	3
8	Transport, Communication and Storage	1.303	5	0.033	2	0.002	5
9	Finance, Insurance and Banking	1.301	6	0.003	6	0.000	1
10	Services	2.0	1	0.016	4	0.001	2
Average		1.376		0.054			

Source: Calculated from Tables 6.1, 6.2 and 6.3.

The correlations between the rankings of sectors on the basis of the above input-output multipliers show that the only positive (even though insignificant) association was found between output and imports criteria, with a Spearman's rank correlation coefficient of 0.61. The rank correlation coefficients between output and exports criteria, and between exports and imports criteria, were found to be negative, at respectively - 0.37 and - 0.16. This absence of association indicates the virtual incompatibility of the policy objective mentioned above.

Taking sectors which had above-average output multipliers, above average-export multipliers, and below-average import multipliers to be the important sectors in the Saudi economy, and by assessing them in terms of possible alternative policy

objectives, such as the maximisation of output, the maximisation of exports (foreign exchange earnings), and the minimisation of imports, we obtain the results presented in Table 6.5. This table reveals that there appeared to be a great degree of incompatibility between the suggested policy objectives, as there was no sector which would allow a maximum dispersion of impact in any of those policy objectives. Indeed, the oil sector was the only sector which qualified as an exports maximiser and imports minimiser, while it did not qualify as an output maximiser. The non-oil minerals sector, however, did not qualify in any of those objectives, along with the agriculture and manufacturing sectors.

Table 6.5: Important Sectors showing Contributions to Proposed Alternative Policy Objectives

Sectors	Maximise Output	Maximise Exports	Minimise Imports
1	NO	NO	NO
2	NO	YES	YES
3	NO	NO	NO
4	NO	NO	NO
5	YES	NO	YES
6	YES	NO	YES
7	YES	NO	YES
8	NO	NO	YES
9	NO	NO	YES
10	YES	NO	YES

Source: Based on Table 6.4.

6.4.5 Income Multipliers

Income multipliers measure increases in income occasioned by a specified change in the economy. The direct effect of increases in output on household income is given by the household row coefficient a_{Hi} for each sector, where a_{Hi} is the appropriate entry in the household row of the A matrix. The direct and indirect effect of an increase in sales of any sector to final demand is derived by

multiplying the direct and indirect output changes, the elements of the Z matrix, by the corresponding household row coefficient, i.e., obtaining $z_{ij}\ a_{Hi}$ for each element. The direct and indirect income multiplier for sector i is obtained simply as $\sum_i z_{ij} a_{Hi}$. The indirect income effect on each sector is calculated as $z_{ij}\ a_{Hi} - a_{Hi}$.

The direct, indirect and induced income multiplier (total income multiplier) is obtained from the household row of the Z^* matrix. The induced effect can be calculated as z_{ij}^* - $z_{ij}\ a_{Hi}$.

Table 6.6 below provides income multipliers for the Saudi Arabian economy sectors. These are provided in three forms, namely (1) the direct income multiplier or household coefficient, indicating the first round effect on household income of an increase in output of each sector. For instance, an increase of one riyal of the non-oil minerals sector would increase household income in that sector by SR 0.004; (2) the direct and indirect income multiplier, including the income increase occasioned in all sectors in the economy by an increase in sales of one riyal to final demand by each sector. For instance, the direct and indirect income effect of the non-oil minerals sector would be SR 0.006, as a result of industrial support requirements. Finally, (3) the direct, indirect and induced effects are listed, including the increase in income due to increased consumer expenditure in Saudi Arabia; this figure is SR 0.009 for the example quoted.

The indirect effect may be calculated in this case as

SR 0.006 – SR 0.003 = SR 0.003;

and the indirect effect as

SR 0.009 – SR 0.006 = SR 0.003, also per SR of increased sales of the non-oil minerals industry sector to final demand of the Saudi Arabian economy.

Table 6.6: Income Multipliers

Sector	Direct	Rank	Direct & Indirect	Rank	Total	Rank
Agriculture, Forestry and Fishing	0.041	7	0.045	7	0.049	7
Oil Production & Refining	0.008	9	0.011	9	0.014	9
Non-Oil Minerals	0.003	10	0.006	10	0.009	10
Manufacturing Industry	0.022	8	0.024	8	0.026	8
Electricity, Gas and Water	0.054	6	0.080	6	0.110	6
Construction	0.120	3	0.140	3	0.163	3
Commerce, Restaurants and Hotels	0.083	5	0.114	4	0.150	4
Transport, Communication and Storage	0.095	4	0.107	5	0.121	5
Finance, Insurance and Banking	0.132	2	0.150	2	0.171	2
Services	0.232	1	0.268	1	0.308	1

Source: Author's calculation based on 1994 input-output table.

The direct income multipliers suggest, in effect, the labour intensity of each sector in the economy. These show, as expected, a wide disparity in those coefficients between sectors, reflecting the differences in labour intensity. These range, for example, from SR 0.003 to SR 0.232 per one riyal of output in the non-oil minerals and services sectors, respectively.

The total (i.e., direct, indirect and induced) income multipliers show a consistency between the sectors in the upper and lower rankings. Those sectors with the highest direct coefficients, namely the services and finance sectors, show also the highest total income multipliers over the economy. This is further evidence of the contribution made by these sectors to the personal income of Saudi Arabian

labour. Each increase of one riyal in the value of the output of the services sector destined to final demand adds an additional SR 0.308 to household income. However, the same riyal increases in the non-oil minerals sector would raise this income by only SR 0.009. The relatively low non-oil minerals' household income multiplier reflects its highly capital-intensive nature.

6.4.6 Employment Multipliers

Both output and income multipliers are calculated from elements within the input-output tables. These tables, however, do not contain elements relating to employment per sector. It is therefore necessary to derive, independently of the tables, an employment coefficient. The simplest method of obtaining this coefficient is the expression of the number of employees per unit of output[11]. Once this coefficient has been obtained, the calculation of employment multipliers parallels to some extent the calculation of income multipliers. The direct effect on employment in each sector of a change in output of sector i will be given by a_{Ei}, the employment equivalent of the household row. The direct and indirect employment effects will be shown as $\sum_i z_{ij} a_{Ei}$ for all sectors. The direct, indirect and induced effects are calculated as z_{ij}^* a_{Ei}, and as $\sum_{i=1}^{n-1} z_{ij}^* a_{Ei}$, i.e., over non-household sectors for the total employment multiplier.

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[11] This method was first proposed by Bills and Barr (1968).

Table 6.7 below presents the employment multipliers of the sectors for the Saudi Arabian economy. These are provided in three forms, parallel to those described above for income multipliers. In general terms, if the wage rate between sectors is constant, employment multipliers would be expected to reflect income multipliers in terms of ranking between sectors. The extent to which the income multipliers and employment multipliers vary in ranking highlights differences in personal income levels between sectors.

Table 6.7: Employment Multipliers

Sector	No. of Employees[1]	Direct	Rank	Direct & Indirect	Rank	Total	Rank
Agriculture, Forestry and Fishing	663,000	28.722	2	30.514	2	30.560	2
Oil Production & Refining	66,000	0.472	9	0.706	9	0.717	10
Non-Oil Minerals	50,200	0.400	10	0.575	10	0.581	9
Manufacturing Industry	538,200	2.692	8	2.837	8	2.861	8
Electricity, Gas and Water	147,400	31.932	1	34.344	1	34.424	1
Construction	580,900	6.720	7	8.845	7	8.985	7
Commerce, Restaurants and Hotels	493,000	13.251	4	16.689	4	16.803	4
Transport, Communication and Storage	310,700	9.389	5	10.603	5	10.710	5
Finance, Insurance and Banking	130,200	8.908	6	10.384	6	10.534	6
Services	1,308,700	17.761	3	23.841	3	24.109	3

[1]Ministry of Planning (1999).
Source: Author's calculation based on 1994 input-output table.

For example, while the agriculture sector (Table 6.6) showed a low requirement for direct income, its direct income in terms of employment (Table 6.7) is relatively high. In contrast, the construction sector shows low labour usage in

terms of employment, but higher contributions to household income, reflecting the higher levels of wages and salaries in this sector. On the other hand, the non-oil minerals sector indicated that the wage rate within the sector is constant.

The direct employment requirements column shows variations between sectors. The relatively high employment requirement of the electricity, gas and water, and agriculture sectors reflects the nature of these sectors as highly labour-intensive. In contrast, the non-oil mineral sector illustrates, again, its highly capital-intensive nature.

6.4.7 Type I and Type II Multipliers

It has been conventional in input-output analysis for some time to calculate Type I and Type II income and employment multipliers. Hirsch (1959) was the first to derive the now standard Type I and Type II income multipliers. The Type II multiplier assumes a linear and homogeneous consumption function, since its calculation requires the insertion of households into the endogenous matrix.

Type I multipliers are expressed as:

$$\frac{\text{Direct and indirect effects}}{\text{Direct effects}}$$

and Type II multipliers as:

Direct, indirect and induced effects
Direct effects

It is important to establish the distinction between the types of multipliers which have been mentioned. For example, the income multipliers described in the sections above measure the direct, indirect and induced effects of a change in sales of one riyal of the output of a sector to final demand. Type I and Type II income multipliers measure the income generated following a riyal change in household payments, as a result of a change in final demand for the relevant sector. In other words, the income multipliers measure the income impact of a change in sales to final demand, while the Type I and II income multipliers measure the income impact of a change in income. Similarly, the employment multipliers measure the employment impact of a change in sales to final demand, and the Type I and II employment multipliers measure the employment impact of a change in employment.

Table 6.8 shows that non-oil minerals has the highest income multiplier when Type I and Type II are considered. This means that for each riyal change in household income of non-oil minerals employees, there will occur in Saudi Arabia a change of SR 1.5 (direct and indirect effects only) and SR 2.25 (direct, indirect and induced effects).

The employment multipliers of the oil sector followed by the non-oil mineral sector were the highest when Type I and Type II are considered. This indicates that for each person employed in the non-oil minerals sector, an additional 0.438

persons will be employed in other industries in Saudi Arabia, taking into account only direct and indirect effects. When induced effects are also included (Type II), this becomes an additional 0.453 persons.

Table 6.8: Type I and Type II Multipliers

Sector	Income Multiplier				Employment Multiplier			
	Type I	Rank	Type II	Rank	Type I	Rank	Type II	Rank
Agriculture, Forestry and Fishing	1.098	9	1.195	9	1.062	10	1.064	9
Oil Production & Refining	1.410	3	1.795	4	1.496	1	1.519	1
Non-Oil Minerals	1.500	1	2.250	1	1.438	2	1.453	2
Manufacturing Industry	1.091	10	1.182	10	1.054	9	1.063	10
Electricity, Gas and Water	1.481	2	2.037	2	1.076	8	1.078	8
Construction	1.167	5	1.358	5	1.316	4	1.337	4
Commerce, Restaurants and Hotels	1.373	4	1.807	3	1.259	5	1.268	5
Transport, Communication and Storage	1.126	8	1.274	8	1.129	7	1.141	7
Finance, Insurance and Banking	1.136	7	1.295	7	1.166	6	1.183	6
Services	1.155	6	1.328	6	1.342	3	1.357	3

Source: Author's calculation based on 1994 input-output table.

This result supports the aim announced by Ma'aden's president, for the company to add 5,000 to Saudi Arabian employment in the non-oil minerals sector, and create about 50,000 new jobs in other related industries in Saudi Arabia by the year 2010 (Idrees, 2001). The employment multiplier of the non-oil minerals sector is quite important for the Saudi Arabian policy-makers in terms of the Saudisation process and employment generation, especially as Saudi Arabian unemployment reached 20% in 2000 (SAMBA, 2001).

6.5 Linkage Effects

The term 'linkage effects', as proposed by Hirschman (1958), refers to economic expansion in a given industry resulting from the development of another industry. To help describe the structural interdependence of the sectors within an economy and, in particular, the Saudi Arabian non-oil minerals contribution to the inter-sectoral integration, Rasmussen (1956) derived two measures. These are the backward and forward linkages indices.

As mentioned earlier, an important feature of the inverse matrix is that it shows the magnitude and level of linkages of each particular industry. Summing across the row gives us the size of the 'forward linkage' of the industry to which the column belongs, while summing down the column we obtain the 'backward linkage' of the industry to which the column belongs. In other words, production in a particular sector has two economic sectors. Firstly, if production is increased in one sector of the economy, then production in other sectors whose products are used as inputs to that sector will also increase. This type of interaction is termed backward linkages. An increase in the same sector's output, on the other hand, means that an extra amount of its products is available for use as input to other sectors. This is termed forward linkages.

Quantification of these linkages can be summarised as follows:

$$b_j = \sum z_{ij}$$

where b_j = backward linkage of sector j

and z_{ij} = element of inverse matrix $(I - A)^{-1}$.

In other words, it is the output multiplier.

As for the forward linkages, this represents the row sum of that inverse, i.e.:

$$f_i = \sum_j z_{ij}$$

This shows the output generated in sector *i*, where final demand in each sector of the economy has increased by one unit. The relative importance of these linkages is measured by either of the respective indices. These are derived as follows:

Let V_j = backward linkage index, then:

$$V_j = \frac{b_j}{\frac{1}{n}\sum_{ij}^{n} z_{ij}}$$

The numerator is the sector's backward linkage, i.e., the output multiplier of the Type I model. The denominator is the average backward linkage of all sectors in the economy. When the index is greater than one, i.e., $V_j > 1$ for a particular sector, this indicates a high backward linkage. In other words, the sector is generating above-average response in other sectors, i.e., other sectors' output is motivated by the change in this sector's output.

Forward linkage index is measured as follows:

$$U_i = \frac{f_i}{\frac{1}{n}\sum_{ij}^{n} z_{ij}}$$

Again, a value of $U_i > 1$ indicates a high forward linkage, in the sense that the sector's output displays above-average response to other sectors' output, such that the sector's output being stimulated by the change in other sectors' output.

When this is applied to the Saudi Arabian economy, the result is as summarised in Table 6.9. It shows these linkages in two ways. Firstly, by using the domestic input coefficient matrix to calculate the domestic linkages, and secondly, by using the total technology matrix (domestic as well as imports) to calculate the total forward and backward linkages.

Table 6.9: Backward and Forward Linkage in Saudi Arabian Economy

Sector	Backward Linkage				Forward Linkage			
	Domestic	Rank	Total	Rank	Domestic	Rank	Total	Rank
Agriculture, Forestry and Fishing	1.095	9	2.245	2	1.213	4	1.225	7
Oil Production & Refining	1.044	10	1.054	10	1.246	2	3.351	1
Non-Oil Minerals	1.113	7	1.865	6	1.167	6	1.274	5
Manufacturing Industry	1.113	8	2.098	3	2.451	1	2.533	2
Electricity, Gas and Water	1.563	2	1.933	5	1.021	10	1.023	10
Construction	1.528	3	1.901	4	1.198	5	1.229	6
Commerce, Restaurants and Hotels	1.283	4	1.389	7	1.039	9	1.056	9
Transport, Communication and Storage	1.196	5	1.313	8	1.145	7	1.298	4
Finance, Insurance and Banking	1.151	6	1.188	9	1.110	8	1.126	8
Services	1.732	1	2.267	1	1.229	3	1.311	3
Average Linkage	1.282		1.725		1.282		1.543	

Source: Author's calculation based on 1994 input-output table.

From an examination of the backward linkages in the above table, one can pinpoint which industries should be encouraged to switch their purchases from foreign to Saudi Arabian suppliers, in order to generate the highest effect on the

total economy. These are services, agriculture, manufacturing, construction, and electricity, gas and water.

The difference between the domestic and the total forward linkages indicates those industries with high potential to replace imported goods. In the Saudi Arabian case, those industries with high potential are oil, followed by manufacturing. Sectors like electricity and commerce have little or no export potential, and are thus demoted in the total forward linkage.

Table 6.10: Intermediate Inputs and Sales of Non-oil Minerals Sector from and to other Sectors of the Economy

(Millions of SR and %)

Sectors	Intermediate Inputs		Intermediate Sales	
	Value	%	Value	%
Agriculture, Forestry and Fishing	0.0	0.0	0.0	0.0
Oil Production & Refining	143.6	11.2	143.6	2.0
Non-Oil Minerals	995.3	77.4	995.3	13.5
Manufacturing Industry	22.5	1.7	5953.0	81.0
Electricity, Gas and Water	4.5	0.3	0.0	0.0
Construction	76.4	5.9	259.0	3.5
Commerce, Restaurants and Hotels	1.0	0.1	0.2	0.0
Transport, communication and Storage	24.7	1.9	0.0	0.0
Finance, Insurance and Banking	1.8	0.1	0.0	0.0
Services	16.8	1.3	0.2	0.0

Source: Based on 1994 input-output table.

The non-oil minerals' sector has a relatively higher backward linkage than forward linkage in the economy. However, compared with other Saudi Arabian sectors, the sector's linkage ranking was, on average, sixth. Nevertheless, it can be argued that the backward index should not be taken on its own as an indication of a high interdependence of this sector with the rest of the sectors, since as much as 77.4% of Saudi Arabian non-oil minerals inputs were drawn from the sector itself,

and only 22.6% drawn from the rest of the economy, as Table 6.10 reveals. Moreover, the relatively low forward linkage index means that the sector poorly supplies downward activities with its output. Of this small supply, the bulk is received by the manufacturing sector, 81% of non-oil minerals intermediate sales were made to this sector.

6.6 Identification of Key Sectors in the Saudi Arabian Economy

Key sectors or 'leading sectors' are defined as those whose backward and forward linkages are greater than unity, as explained by Hirschman (1958). The extent of the strength of backward and forward linkages of sectors in an economy is usually used to identify leading or key sectors in that economy. If the backward linkage of sector *A* is larger than that of sector *B*, this means that a one unit expansion of sector *A*'s output would be more stimulating to the economy than an equal expansion in *B*'s output. In terms of productive activities, it would generate throughout the economy, i.e., expanding the demand side. Similarly, if sector *X*'s forward linkage is higher than that of sector *Z*, it could be concluded that, in terms of productive activity that it would support, a unit of expansion in sector *X*'s output would be more essential to the rest of the economy than the same expansion in that of sector *Z*, i.e., expanding domestic supply for goods demanded by other sectors.

Given the Hirschman definition, and using the domestic criteria, there appear to be no key sectors in the Saudi Arabian economy in Table 6.9. Looking at the total linkage, only the manufacturing sector seems to be described as a key sector.

Although the result depicted above is valuable to the planners in deciding their priorities, many economists[12] have criticised the practice of measuring key sectors in this way. In the case of Saudi Arabia, for instance, this method ignores the ability of a sector to generate income, this point being evident by the status of the oil sector. Furthermore, it could be argued that some sectors have gained from the backward linkages created by the investment.

Hazari (1970) introduced a new measure to overcome this problem. Such a measure could be used as well as the above method to identify the key sector. The method measures the variation of coefficients as follows:

$$V^*_j = \sqrt{\frac{{}^{1}\!/\!_{(n-1)} \sum_i (z_{ij} - \frac{1}{n} z_j)}{({}^{1}\!/\!_{n}) z_j}}$$

$$U^*i = \sqrt{\frac{{}^{1}\!/\!_{(n-1)} \sum_j (z_{ij} - \frac{1}{n} z_i)}{({}^{1}\!/\!_{n}) z_i}}$$

Low V^*_j means that a particular industry relies evenly upon the system of industries. On the other hand, a high index implies that the industry draws unilaterally on the system of industries. U^*i can be interpreted in the same way.

Therefore, by applying the new method of coefficients of variation, two methods have been proposed to identify key sectors. In the first method, key sectors are

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[12] For detailed literature on a critical view of these objections, see McGilvray (1978).

identified as those which are presented by Hirschman, i.e., $V_j > 1$ and $U_i > 1$, and in the second method, V^*_j and U^*i are relatively low. In fact, these are very restrictive criteria, and hence, only a small number of sectors could satisfy these requirements.

Table 6.11: Coefficients of Variation

Sector	Backward Linkage				Forward Linkage			
	Domestic	Rank	Total	Rank	Domestic	Rank	Total	Rank
Agriculture, Forestry and Fishing	0.101	9	0.794	5	0.943	7	0.095	6
Oil Production & Refining	0.099	8	0.993	10	0.876	4	0.054	1
Non-Oil Minerals	0.102	10	0.828	7	0.983	10	0.096	7
Manufacturing Industry	0.094	6	0.775	4	0.608	3	0.065	2
Electricity, Gas and Water	0.081	2	0.718	2	0.981	9	0.100	10
Construction	0.082	3	0.732	3	0.893	5	0.090	5
Commerce, Restaurants and Hotels	0.086	4	0.827	6	0.970	8	0.098	8
Transport, Communication and Storage	0.093	5	0.885	8	0.939	6	0.089	3
Finance, Insurance and Banking	0.098	7	0.963	9	0.302	2	0.099	9
Services	0.079	1	0.692	1	0.287	1	0.090	4
Average	0.092		0.821		0.778		0.088	

Source: Author's calculations.

However, given that backward linkages are more caused, while forward linkages are permissive, Schultz (1976) has defined the key sectors as those which present high backward linkages (V_j greater than unity), and low coefficients of variation. Applying the above method, which was proposed by Hazari (1970), or the one proposed by Schultz, we get the results as shown in Table 6.11 above.

Accordingly, for a sector to qualify as a key sector it should satisfy the new definition. This sector should have above-average backward and forward linkages and relatively low dispersion. In order to identify these sectors, we classified the sectors according to six different criteria, as shown in Table 6.12.

Table 6.12: Identification of Sectors by Criteria

Criteria	Sectors
1. Sectors with above-average V_j	1,3,4,5,6,10
2. Sectors with below-average V^*_j	1,4,5,6,10
3. Sectors with both above-average V_j and below-average V^*_j	1,4,5,6,10
4. Sectors with above-average U_i	2,4
5. Sectors with below-average U^*i	2,4
6. Sectors with both above-average U_i and below-average U^*i	2,4
7. Key Sectors (Sectors which satisfy both criteria 6 and 3)	4

Source: Based on Tables 6.9 and 6.10.

There was only one sector with simultaneously both above-average V_j and below-average V^*_j, and above-average U_i and below-average U^*i, namely the manufacturing sector. Furthermore, the manufacturing sector was the only key sector, even when we also applied the Schultz definition for the key sector. The reason is that the other sectors with high V_j & low V^*_j had either low U_i or high U^*i, and vice versa. This is indicated by the Spearman rank correlation results given in Table 6.13.

Table 6.13: Results of Spearman's Rank Correlation between Criteria

Ranking	Correlation
Backward Linkages V_j and Backward Coefficient of Variation V^*_j	0.88
Backward Linkages V_j and Forward Linkages U_i	-0.07
Backward Linkages V_j and Forward Coefficient of Variation U^*i	-0.03
Forward Linkages U_i and Backward Coefficient of Variation V^*_j	-0.16
Backward Coefficient of Variation V^*_j and Forward Coefficient of Variation U^*i	-0.16
Forward Linkages U_i and Forward Coefficient of Variation U^*i	0.927

Source: Author's calculations.

Indeed, the association between the backward and forward linkages was negative, as the rank correlation coefficient indicates (-0.07). The association between backward linkages V_j and the forward coefficient of variation U^*i, and that between backward coefficient of variation V^*_j and forward coefficient of variation U^*i, were also negative at - 0.03 and - 0.16, respectively, indicating a poor integration between sectors.

As far as the non-oil minerals sector was concerned, the sector did not qualify as a key sector. The non-oil minerals sector actually had an average backward linkage index, and an above-average corresponding coefficient of variation, which means that the sector relied relatively heavily on the rest of the sectors for its inputs. This also means that the linkages of the sector were confined to only a few sectors of the economy and to the sector itself, as indicated in Tables 6.12 and 6.13. On the other hand, the sector did not have either above-average forward linkage or a relatively low corresponding coefficient of variation. It must also be noted that Sectors 7, 8 and 9 were the only sectors which did not satisfy any of the criteria

cited in Table 6.12, in spite of the huge amount of both public and private investment given to these sectors at the expense of other sectors. These sectors were commerce, transport, and finance and banking.

It must be indicated here that the oil sector did actually have both an average forward linkage index and a low average corresponding coefficient variation, which means that the other sectors relied heavily and evenly on the sector's outputs. On the other hand, the oil sector did not have either above-average backward linkage or a relatively low corresponding coefficient of variation. This means that the sector did not rely evenly on the rest of the sectors of the economy. This was expected, as the oil sector in Saudi Arabia uses highly sophisticated machinery and equipment which are not supplied by the domestic market. This analysis and results have indicated the inability to spread the oil linkages over a wide range of sectors. Thus, it can be said that the Saudi Arabian oil sector is an enclave with respect to the rest of the economy.

6.7 Conclusion

An input-output model was applied in this chapter to investigate both the inter-industry linkages between the non-oil minerals sector and the other sectors of the economy and the sector's multipliers. The Saudi Arabian input-output table reflects the dominance of oil as the main source of foreign exchange, and hence the relatively low multipliers, which indicates the poor integration between the sectors.

With regard to the non-oil minerals sector, even though the sector has moderate backward and forward linkages, these linkages were developed only with the sector itself and a few other sectors, as indicated by the high coefficients of variation of those linkages. Thus, the sector did very little in terms of inducing the inter-sectoral integration of the economy. In addition, the estimation of the economic multipliers has shown (with the exception of its relatively high exports' multiplier) that the sector had insignificant impacts on the economy. However, when induced effects are included, the sector reveals relatively high income and employment multipliers. The sector had the highest index of income generation and the second employment generation in the Saudi Arabia economy. This indicates that the non-oil minerals sector can be stimulated by an increase in final demand, and generate more income and employees than other sectors of the economy. Therefore, it is expected that, for instance, the impact of an expansion and/or an introduction of a new industry within the non-oil minerals sector would have significant effects on the Saudi Arabian economy.

The oil sector was perceived, by the Saudi Arabian government, as the key sector. However, we have shown empirically that the sector loses its key sector status when the coefficients of variation of its linkages are taken into account. The sector which we identified as a key sector in the Saudi Arabian economy in 1994 was the manufacturing sector. The manufacturing sector seemed to offer maximum effects on all the policy objectives which we have suggested. However, while this fact confirms the important role played by the manufacturing sector in terms of these objectives, it does not necessarily confirm the incompatibility of these policy

objectives in the Saudi Arabian case as applied to the non-oil minerals sector. This is simply because the major development and expansion of the non-oil minerals sector, as shown in Chapter 4, has taken place since the Saudi Arabian input-output table was prepared in 1994.

Chapter 7: Economic Impacts of New Non-Oil Minerals Industry

7.1 Introduction

We have seen in the previous chapter that the economic impacts of the non-oil minerals sector were insignificant in 1994. However, since then, the sector has expanded remarkably, and is expected to increase its contribution in the coming years. This is mainly due to the new steps and incentives provided by the Saudi Arabian government to develop and promote the sector, as shown in Chapter 4. Therefore, we are interested in this chapter to examine the effects of an expansion within the non-oil minerals sector resulting from changes in the final demand for that sector product.

Specifically, this involves an empirical application of an input-output approach to the analysis of the economic impact of the introduction of three new mining industries. Those are the aluminium industry, the phosphate industry, and the iron industry. The three new mining industries will be inserted inside the existence of the Saudi Arabian input-output table of 1994. This chapter presents quantitative results in terms of projected industry output, household income and employment multipliers (effects). The chapter will draw on the economic impacts of these major extensions in the sector, individually and collectively.

7.2 Impact of New Industry

As mentioned in the previous chapter, input-output multipliers have their widest application, particularly, in the analysis of a small change in composition of

demand. Amongst them is examination of the effect on an economy of starting a new industry. Let the input-output table represent the Saudi Arabian economy in equilibrium terms and subject it to a shock such as the location of further major industry inside the country. When the repercussions of the shock have moved through the economy, what will be its new equilibrium position in terms of industries' output, household income, and employment? This involves the same standard procedure applied in the previous chapter, with slightly additional procedures. An overview of the major developments and refinements of the procedures will be introduced here[13].

Tiebout (1967) was the first to suggest that the impact on an economy of a new industry can be analysed by augmenting the original input-output table. His technique involves the following steps: (1) augment the input-output table with a new row and column representing the new industry; (2) invert table to calculate new multipliers, including multiplier for the new industry; (3) use projected final demand sales of the new industry to estimate the effects of the economy's output, income and employment, as discussed earlier. However, Bonner and Fahle (1967) have paid attention to some additional adjustments that may be required in step (1), before calculating the inverse, to take account of the changes in direct coefficients due to the change in country trade resulting from the new industry, i.e., some output previously exported may now be an input to the new industry.

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[13] An extended literature review of the analysis of impacts of a new industry can be found in Richardson (1972), Stone (1973), and Mandeville and Jensen (1978).

Sadler (1973) has recognised that the above technique shows the impact only of the production of the goods, and takes no account of the impact on the economy of building the factory or plant. In order to measure the total impact, however, he has added an additional significant refinement to the measurement of the impact of a new industry by considering two phases of impacts: the constructing phase and the operating phase. In the first, constructing, phase a multiplier for new construction can be applied to the investment used in building the factory, and the result can be taken as the impact of this investment output, incomes, and employment during the construction period, to represent the average impact for a year. The second, operating, phase however, consists of applying the industry multiplier to final demand, the exports and consumption of the new product, in order to assess the long-term effects of the industry itself. The latter will come into effect only when the construction of the factory is completed and the multiplier effects of the latter expenditure are likely to have worked themselves out. Similarly, measurement of the impact of the operating phase will involve augmenting the input-output matrix with a new row and column representing the new industry.

If more than one industry come into existence at the same time, however, the developments can be measured in combination by augmenting the matrix with m (number of the new industries) rows and columns simultaneously. Economic impacts can be measured in both aggregate and relative terms. In aggregate terms, total increases in output, income and employment resulting from the given

economic stimulus can be calculated; in relative terms, the increases in output, income and employment can be related to a unit increase in the original stimulus.

The assumptions of an input-output model in investigating the impact of new industry remain the same as in the previous chapter. This is because we are concerned with evaluating the short-run effects of the introduction of new industries into the Saudi Arabian economy. Similarly to the previous chapter, the effects of any final demand change, real or simulated, can be considered an economic impact on a country. The emphasis here is to draw distinctions between the use of an input-output model in impact analysis and forecasting. Forecasting which may violate these assumptions is not involved.

However, two more assumptions must be added when analysing the effect of introducing a new industry to validate the model.

(1) There are unemployed or under-utilised resources in the Saudi Arabian economy, otherwise the introduction of the new mining industry will do no more than shift resources from other sectors to the non-oil minerals sector.

(2) The operation of the new mining industry must be associated with an increase in the final demand in the economy, such as government expenditure, capital formation, or net exports. If it is not, the new mining industry does no more than displace an existing one, and even if it uses hitherto unemployed resources in one area, it will cause unemployment of resources in another.

7.3 New Non-Oil Mineral Industries

We have seen in Chapter 4 that Ma'aden already had the permits and licences to explore some non-oil minerals resources. They have also intended to mine and build several new, non-oil minerals projects within the present national Five-Year Plan. Three of these projects approved so far concerned the largest mining industries inside Saudi Arabia. Aluminium, phosphate, and iron projects are the largest in terms of their reserves, capital and operation costs.

Investments in these projects have attracted, besides the local mining companies, some of the large international corporations. However, Saudi Arabian mining law requires a detailed economic and technical perspective to be offered by investors before any release action can be taken. This perspective has to meet the Saudi Arabian objectives in mining development policy, otherwise the offer will be rejected. Recently, Ma'aden has met the Saudi Arabian policy requirements, especially in terms of integrating the sector with the economy, by offering to process the ore locally instead of extracting the ore and exporting it as a raw material. Although Ma'aden has the required capital to finance these projects, it is intended to have a joint venture with large corporations in this field. This will ensure transfer of the technology needed to construct the plants, as well as help in marketing the products in the operation phase.

DMMR and Ma'aden have studied these projects extensively from the economic and technical points of view. The economic information on these projects was collected from various official sources. A brief economic and locational description of these industries will be introduced and outlined below.

7.3.1 Aluminium Industry

The main source on the aluminium industry data was the DMMR (1993). The proposed production of the metal aluminium from its ore, bauxite, consists of three distinct phases:

(1) Mining and screening. Bauxite is mined and screened at the ore site, Az Zabira.

(2) Alumina refinery. Refining is a process which involves dissolving out aluminium oxide with caustic soda. The refinery plant will be located at the Az Zabira ore site.

(3) Aluminium smelter. The smelting process involves dissolving alumina in cryolite flux and electrically reducing with carbon. Often, smelting is done at the ore site. Az Zabira is an exception to the general case, primarily owing to the isolation of the location, the smelter plant will be built instead at the industrial city, Al -Jubail port, on the Arabian Gulf. This will reduce the cost of the power source needed for the smelter, due to the low price offered by Al-Jubail. However, the 650 km between Az Zabira and Al-Jubail would maximise the cost of transportation. The building of a railway between them was finally suggested to overcome the transportation cost. After long negotiation, the Saudi Arabian government has been persuaded to finance part of the proposed railway, and to extend it further by linking it with other potential mining locations in the country[14].

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[14] The work on the railway is supposed to be started in 2002 (Al Riyadh, 2001).

Generally speaking, the aluminium industry exhibits significant economies of scale of production, and concomitant large initial capital investment requirements. In addition, the production process is one of continuous operation for 24 hours/day throughout the year. As indicated above, the three developments included in the analysis for the aluminium industry are (1) mining facilities such as laboratory, milling plant, etc., (2) alumina refinery plant, (3) aluminium smelter plant.

The initial proved mine life would be 20 years. In the operating phase, the refinery plant is expected to produce, annually, 1 million tonnes of alumina. On the other hand, the smelter will produce 300 hundred tonnes. Investment in the project is estimated at SR 404 million. The plants will require 1550 employees. The major inputs into the process are bauxite, alumina, electricity, fuel oil, and labour. Other raw material such as coke, pitch, aluminium fluoride, and soda ash will be imported and used as input. The project is likely to be fully operational in 2003.

7.3.2 Phosphate Industry

The main source of data on the phosphate industry was the DGMR (1992). The project has been designed for the production and concentration of phosphate ore at the mine site, Al-Jalamid. The concentrate will then be transported by the proposed railway to Al-Jubail, where part of it will be used to produce diammonium phosphate (DAP) fertiliser, and the reminder will be exported. Therefore, the developments included in the analysis for the phosphate industry

are the concentration plants and the railway to transport the concentrate to Al-Jubail.

The proved life of the mine is 20 years, at an annual production of 11 million tonnes of concentrate. Investment in the project is estimated at SR 6.5 billion. The significant capital cost is due to the high-cost nature of phosphate processing. In addition, the phosphate industry, owned by SABIC, will contribute to a part of the proposed railway. The plants will require 1800 employees. The major inputs into the process are phosphate, electricity, fuel oil, and labour. The project is likely to be fully operational in 2004.

7.3.3 Iron industry

The main source of data on the iron industry was DMMR (1994). The project has been designed for the extraction of iron ore and the production of iron pellets from Wadi Sawawin. Part of the production will be sold to the iron and steel plants locally, and the remainder will be exported.

The proven life of the mine is 25 years, at an annual production of 2.2 million tonnes of iron and pellets. Investment in the project is estimated at SR 2.8 billion. The plants will require 1220 employees. The major inputs into the process are iron ore, electricity, fuel oil, and labour. The project is likely to be fully operational at the end of 2003.

7.4 Economic Impact Analysis

In order to insert the additional row and column representing each project, the data of the three new industries were deflated in 1994 Saudi Arabian riyals. Therefore, it should be borne in mind that the procedures are estimating the effect on the 1994 Saudi Arabian economy of developments that will be fully operational in the 2010s. On insertion into the input-output table, all data need to be ultimately in the form of cost coefficients, i.e., inputs per riyal of output. Appendix C shows the augmented construction matrix and operating matrix, respectively, with the new rows and columns representing the new industries.

7.5 Construction Phase of Projects

The required information on construction costs incurred in each new industry was sufficiently detailed in their presented studies. The Saudi Arabian input-output for 1994 was augmented with a new row and column representing the building and construction sector, associated specifically with construction of each of the three new industry plants individually. The construction phase impact was measured for the peak year in each project in order to catch the maximum effect. The multiplier effects of the construction phase of the new industries are summarised in Table 7.1 below, and can be interpreted as follows:

Table 7.1: Construction Phase of New Industries' Multipliers

Multipliers	Aluminium	Phosphate	Iron
Output			
Direct	0.481	0.641	0.174
Indirect	1.215	1.302	1.072
Induced	0.930	1.043	0.477
Total	2.625	2.985	1.724
Total Output[1]	3.625	3.985	2.724
Simple Output[1]	1.696	1.943	1.247
Income			
Direct	0.385	0.313	0.279
Indirect	0.268	0.295	0.069
Induced	-0.203	-0.205	-0.045
Total	0.405	0.403	0.303
Type I	1.696	1.943	1.247
Type II	1.169	1.288	1.086
Employment			
Direct	18.077	17.188	17.442
Indirect	12.574	16.205	4.303
Induced	8.117	6.909	5.285
Total	38.768	40.302	27.030
Type I	1.696	1.943	1.247
Type II	2.145	2.345	1.550

[1]Includes unit initial stimulus.

Source: Author's calculation based on 1994 augmented input-output table.

7.5.1 Output Effects

Each riyal invested in the construction of the new projects, i.e., aluminium industry, phosphate industry, and iron industry, can be expected to produce an immediate, direct effect (first round) on the output of other intermediate sectors of SR 0.481, SR 0.641 and SR 0.174, respectively. Further industrial support requirements (indirect effects) associated with each riyal of construction activity will require additional SR 1.215, SR 1.302 and SR 1.072, respectively, from Saudi Arabian industries. The induced effect of each riyal invested, i.e., those effects on output originating from increased household consumption arising from increased output will be SR 0.93, SR 1.043, and SR 0.477, respectively.

The total (direct, indirect and induced) effect of each riyal invested in the developments will be SR 3.625, SR 3.985 and SR 2.724, respectively, i.e., each SR invested in each of the aluminium, phosphate, or iron industries can be expected to bring forth an additional SR 2.625, SR 2.985 and SR 1.724, respectively, in the output of Saudi Arabian industries. If only direct and indirect effects are being considered, the multipliers become SR 1.696 for aluminium, SR 1.943 for phosphate, and finally, SR 1.247 for the iron industry.

7.5.2 Income Effects

The income multipliers in Table 7.1 indicate the effects on household income which can be expected to accrue as a result of each riyal invested in the construction phases of the new industries. They show, for instance, that each riyal invested would directly increase household income through payments to the construction workforce of SR 0.385 for aluminium, SR 0.313 for phosphate, and SR 0.279 iron industry. Furthermore, the indirect household income through industrial support linkages for the same riyal invested will be SR 0.268, SR 0.295, and SR 0.069, respectively.

However, the interesting impact will be the induced effect resulting from investing one riyal in each of the above three new industries. The induced effects of household income were all negative. Bearing in mind that $z_{ij}^* - z_{ij}\ a_{Hi}$ this means that for each one riyal invested in each of aluminium, phosphate and iron industries there will be a leakage in household income of SR 0.203, SR 0.205 and SR 0.045, respectively. This could be explained by the fact that investment in the

new industries will cause more imports to be used as input in the construction phase, or/and by the remittances of foreign labour being employed in these industries. This leakage may not seriously affect the investment in the new industries, and the Saudi Arabian economy in turn, due to the fact that the construction phase is a short period only; less than 5 years.

The total income effects are expected to be low and affected by the negative induced income. They are estimated at SR 0.405 for aluminium, SR 0.403 phosphate, and SR 0.303 iron industries. The Type I and II income multipliers for the aluminium industry show respectively that for each riyal change in households of construction employees, there will occur a change of SR 1.696 and SR 1.169. For the phosphate industry, the Type I and II income multipliers become, respectively, SR 1.943 and SR 1.288. Finally, for the iron industry they become, respectively, SR 1.247 and SR 1.086.

7.5.3 Employment Effects

The employment multipliers indicate the increase in employment measured in persons which can be expected to occur as a result of each SR 1,000 invested in construction. They show, for instance, that each SR 1,000 invested in the aluminium industry construction could result in the employment of 18 persons as the direct effect, of 13 persons as the indirect industrial support effect, and 8 persons from induced consumption effect; thus a total of 39 could be employed for each SR 1,000 spent on the aluminium industry. Similarly, a total of 40 and 27

persons would be expected to be employed, respectively, for each SR 1,000 spent on the phosphate and iron industries.

However, the relatively high employment multipliers reflect the high labour intensity required for the construction phase, especially for the railway network. The other reason could be, as mentioned in the procedure earlier, the choice of industries' peak years. The timing of construction of the various developments has a considerable effect on the results. For instance, the aluminium industry construction workforce in the peak year is 940, while in the next year it will be reduced to 600 only. Therefore, the construction multipliers indicate the maximum impacts arising from a particular year during the construction phase.

In contrast, the Type I multiplier indicates that for each person employed in the construction phase of the aluminium project, an additional 1.696 persons are employed in industries in Saudi Arabia. In Type II, this becomes an additional 1.145 persons. Similarly, Type I and Type II employment multipliers for phosphate and iron industries are 1.943 and 1.247 persons, respectively, while their Type II employment multipliers are expected to become an additional 1.345 and 0.55 persons, respectively.

7.6 Operating Phase of Projects

The same procedure was applied using the estimated operating data for the three industries. Our objective was extended further to measure the cumulative effect of the three new industries together. Thus, the new industries were integrated into Saudi Arabian matrix.

Unlike the construction phase, where only individual impacts were calculated, for the operation phase, the aggregate impact of the new industries was calculated also. Although the former phase will cause some economic impacts, such impacts will not be permanent, but will occur only as a result of current construction activity. The aggregate calculation for the latter phase will measure the permanent impact of these industries within the Saudi Arabian economy. Both relative and aggregate output, income and employment multipliers relating to the operational phases of the three projects are presented in Table 7.2.

Table 7.2: Operational Phase of New Industries' Multipliers

Multipliers	Aluminium	Phosphate	Iron	Aggregate
Output				
Direct	0.537	0.551	0.565	0.902
Indirect	1.397	1.288	1.252	0.884
Induced	0.673	0.500	0.555	0.546
Total	2.607	2.339	2.372	2.332
Total Output[1]	3.607	3.339	3.372	3.332
Simple Output[1]	1.934	1.839	1.817	1.786
Income				
Direct	0.395	0.342	0.422	0.382
Indirect	0.369	0.287	0.345	0.300
Induced	-0.092	-0.130	-0.212	-0.208
Total	0.666	0.559	0.555	0.474
Type I	1.934	1.839	1.818	1.785
Type II	1.701	1.459	1.315	2.304
Employment				
Direct	1.304	1.370	1.393	1.352
Indirect	1.218	1.150	1.138	1.063
Induced	0.877	0.685	0.773	0.738
Total	3.399	3.205	3.304	3.153
Type I	1.934	1.839	1.817	1.786
Type II	2.607	2.339	2.372	2.332

[1]Includes unit initial stimulus.
Source: Author's calculation based on 1994 augmented input-output table.

7.6.1 Output Effects

An examination of Table 7.2 shows, to a great extent, similarities between the three proposed new industries in terms of their multiplier impacts. For instance, each riyal of output of the aluminium industry (mining, refining and smelting) will produce an immediate (direct) effect on the output of industries in the Saudi Arabian economy of SR 0.537. In other words, 53.7% of the aluminium industry's inputs are purchased locally.

The direct linkages are mainly for the smelter's use of electricity and alumina. Further industrial support or indirect effects illustrate some of the actual linkages existing. The relatively high indirect effects, SR 1.397, also could be attributed to the fact that the refinery purchases the bauxite locally. Compared to the indirect effect, the induced effect is relatively low. The simple output multiplier for the aluminium industry is SR 1.934, reflecting the strong linkage between the entire developments of each new industry. This is due to the fact that the aluminium industry, generally, shows a high degree of vertical integration.

The relative high direct output in the aggregate reflects the high linkages between the three industries themselves, while the relatively small indirect output effect on the aggregate suggests the low linkages with other industries in the Saudi Arabian economy. However, the output multipliers for the aggregate are generally similar to those of the individual new industries.

7.6.2 Income Effects

Income multipliers in all three proposed new industries are again, to a great extent, similar. The low income multipliers illustrate the effect of highly capital-intensive industries. For instance, the high direct income effect, representing 39.5% of the aluminium industry's cost structure, reflects the labour intensity of aluminium. In addition, the indirect income multipliers for all three industries are also low, reflecting the weak linkages with other industries.

The negative induced income multiplier reflects the existing leakage and the relatively weak linkages with other industries. For instance, in the aluminium industry, there is a leakage of 0.09% resulting in each riyal paid to households. This leakage could be in the form of importing raw material for the industry, or could be in the form of remittances by the foreign labour working in these projects.

Type I and II multipliers are relatively high, reflecting in general the strong linkages between these industries and other industries in the economy. Income multipliers for the aggregate are close to those for each individual industry. Therefore, they can be interpreted in the same way as the income multipliers of each new industry.

7.6.3 Employment Effects

The capital-intensive nature of the mining industries and their strong direct linkages are reflected even more dramatically in the employment multipliers in Table 7.2. Each SR 1,000 of turnover of each project, and for the three projects in

aggregate, could be expected to result directly in the employment of about 1.3 persons. Indirect employment per SR 1,000 of turnover in the three new industries is 1.218, 1.15 and 1.138 persons, respectively. For every worker in the new industries, the Type I employment multiplier suggests that an additional 0.934, 0.839 and 0.817 jobs will be created respectively in new industries.

However, the year on which the input-output table is based has considerable implications for the interpretation of the employment multipliers. Since the Saudi Arabian table pertains to 1994, we should expect that the employment multipliers calculated from this table would overestimate impacts pertaining to 2000 and beyond. According to Jensen (1978) all industries, including mining, are becoming more capital-intensive over time, with mechanisation displacing labour, and, thus, dated employment multipliers will tend to overestimate employment impact.

7.7 Backward and Forward Linkages of New Industries

It is expected that the development of these industries could attract further substantial light and heavy manufacturing to Saudi Arabia. For instance, the advice associated with the aluminium industry suggests that forward linkage industries to the smelter, such as aluminium fabrication and finishing plants, are expected to be in Saudi Arabia. The location of the proposed aluminium smelters by the sea supports this expectation of a pull on later fabricating operations. This is mainly due to the fact that aluminium fabrication plants are market-oriented in their location, since ingots, being less bulky than aluminium sheet, cost less to transport. Similarly, the manufacture of finished goods is market-oriented.

In contrast, when backward linkages are considered, these industries are not expected to attract further substantial light or heavy manufacturing. Industries, however, they may indirectly attract further industry by enhancing Saudi Arabian reputation as an industrial growth country. As indicated earlier, the railway linking both Az Zabira and the phosphate mining sites to the important industrial city on the Arabian Gulf, Al-Jubail, will be the infrastructure directly associated to these industries. This will involve also other infrastructures to serve these areas, such as bridges, improved road access, a power feeder line, water, and port facilities.

7.8 Conclusion

As an application of input-output analysis, this chapter has synthesised a system of measuring the economic impacts of new non-oil mineral industries, incorporating the following technical features: both the construction and operating phase impacts of new industries can be considered, and the impact of several different industries can be examined. The model was empirically applied to assess the impacts, in terms of industries' output, household income, and employment on the Saudi Arabian economy, of the developments in the aluminium, phosphate and iron industries. These projects are all likely to be in operation before mid-2010.

In the construction phase, it was found that the new mining industries have relatively high output and employment multipliers. The railway network as well as the smelters and refineries were possibly the main reason. In contrast, income

multipliers were relatively low, due to the leakages caused by foreign workers in this phase. In the operation phase, however, it was found that the new industries have strong intra-industry linkages, as well as inter-industry linkages with each other. On the other hand, the new industries have relatively small linkages with other sectors of the Saudi Arabian economy. This could be mainly due to the use of imported machines and other imported inputs. The relatively high income multipliers reflect the high linkages of these new industries with other sectors in the economy. The new industries will created little additional employment, reflecting the capital-intensivity of the mining industries.

The emphasis, in this chapter, was on measurement, which implies a focus on the quantitative as distinct from the qualitative aspects of impact. Only economic effects were considered, to the exclusion of other impacts such as social, political and environmental.

Chapter 8: Impact of Oil Boom on Non-Oil Minerals and Saudi Arabia Economy: A Dutch Disease Approach

8.1 Introduction

While the oil boom accelerates economic development and raises the standard of living for an oil exporting country, it creates imbalances in the pattern of sectoral growth. It is widely accepted that in an open economy, especially when operating at or near full employment, an increase in the price of an exportable resource or discovery of a new resource results in the relative expansion of non-tradable sectors and the relative contradiction of tradable sectors.

This chapter is an attempt to provide an empirical study of some of the structural changes which have taken place in the Saudi Arabian economy occasioned by the oil export price increase, on the one hand, and the oil price decline in 1986 onwards, on the other. The reason is to show that the oil boom might be considered as an obstacle to the development of the non-oil minerals sector and hence to economic diversification in Saudi Arabia. The chapter will begin with a brief review of Dutch disease theory.

8.2 Dutch Disease Theory

The discovery, in the1970s, of oil and natural gas in Netherlands gave a boost to the Dutch currency, the guilder. As a consequence, the guilder became a highly sought after currency. The value of the guilder appreciated relative to other currencies, causing the price of Dutch exports in the currencies of the exporting

countries to rise. As a result, the Dutch exports of manufacturing products declined. This phenomenon is addressed in the literature under the name of 'Dutch disease'. Some economists, however, believe that oil and gas are not the only causes of Dutch disease. Corden (1984), for instance, argues that the boom in the technologically advanced part of Japan's manufacturing sector in the 1960s had adverse effects on the less dynamic tradable sectors. Corden also stated that the discovery of gold in Australia in the eighteenth century and in Spain in the sixteenth century in its colonies are other examples of the 'Dutch disease'.

However, the Dutch disease is not unique to developed countries. The recent growth in oil and gas industries has led many economists to study the impact of a booming industry on the domestic economy. Most of the studies seem, theoretically, to agree that there is relative increase in the non-tradable sectors, such as services, relative to the tradable goods sector, e.g., manufacturing and agriculture. Hence, the output of the tradable sectors will contract relatively. The last point can be explained as follows. Under a fixed exchange rate, a booming (resource exports) traded sector will cause the domestic spending to go up. If the short-run response to higher demand of non-tradable sectors were not large, prices of non-tradable sectors' goods would rise. This would lead to higher prices which, in turn, would raise profits if input costs were to lag behind output prices.

The basic model can be summarised as based on the Corden (1984) model, and as developed by Neary and Wijnbergen (1986). There are three sectors, the booming sector (B), the tradable or lagging sector (T), and the non-tradable sector (N). The

first two sectors produce tradable goods which face a given world price. The prices of the non-tradable sector are determined within the domestic economy through the interaction between domestic supply and demand. Output is produced using the neo-classical production function with capital and labour. Capital is fixed and cannot be shifted between sectors. Labour is mobile between sectors.

The boom in sector B is assumed to occur due to the following causes. However, these are not the only ones: (1) a once and for all technical enhancement in the sector which is confined to the economy in question, (2) discovery of a valuable new source, (3) an exogenous increase in the price of the sector's product. This will increase the aggregate income of the factors employed there. It hinges on the presumption that the boom will improve the current account balance, and part of this revenue will be spent on the non-tradable sectors. In studying Dutch disease, one confronts two effects resulting from the resource boom: the spending effect, and the resource movement effect.

8.2.1 Spending Effect

The spending effect, as explained by Corden and Neary (1982), can be analysed through the following general equilibrium model:

$$Q^n \frac{p_n}{p_t} = C^n\left(\frac{p_n}{p_t}, Y\right)$$

where:

Q^n represents output of non-tradable goods,

C^n represents consumption of non-tradable goods,

$\frac{p_n}{p_t}$ represents relative prices of non-tradable to tradable goods,

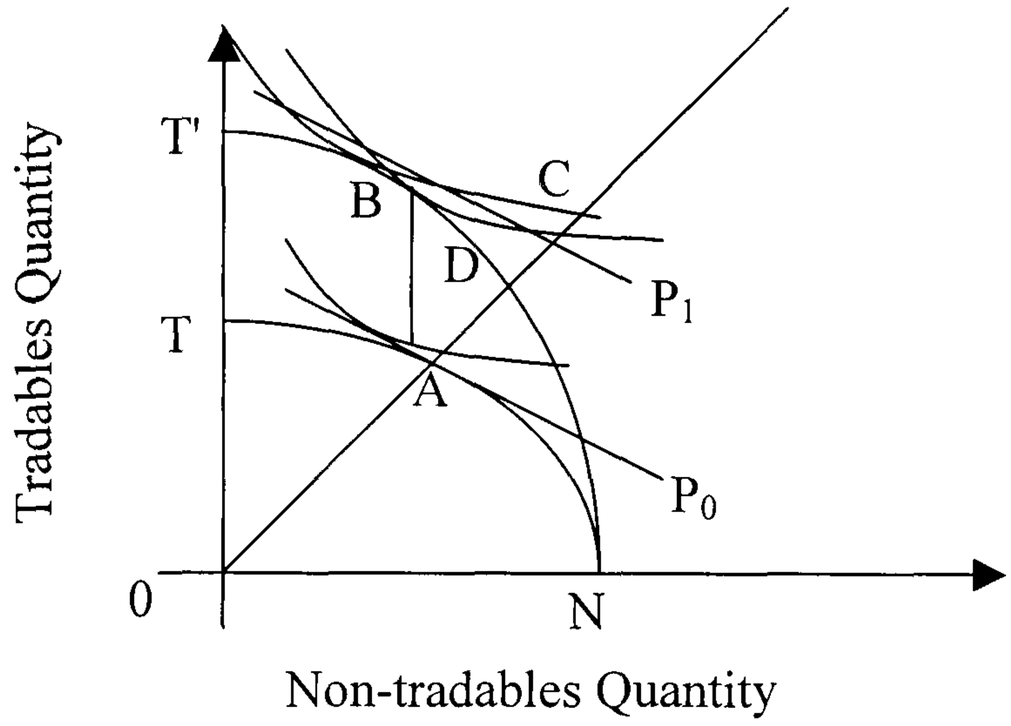
Y represents income.

An increase in the demand for non-tradable goods will raise their price. An increase in the price or in the revenue of oil will raise the income of the factors employed there (providing that the booming sector, oil, employs a negligible fraction of the labour force). Spending will occur either directly by the owners of the factors or indirectly by the government. The production possibility frontier (PPF) is the initial endowment of the economy.

In order to explain how the spending effect mechanism works, as illustrated in Figure 8.1 below, we assume that the economy produces two goods. One is a composite of oil goods and tradable goods (T), and the second is a non-tradable good (N). The price of N is domestically determined, while the price of T, precisely tradable goods, is exogenously determined. Initially, we are at point A, where the price line P_0 is tangent to the original PPF. At this point, producers maximise their profits by setting the marginal rate of transformation equal to the price ratio P_0. Utility maximisation, however, requires that the marginal rate of substitution is equal to the price ratio too. If we assume that the boom is defined as a transfer from the rest of the world which is embodied in tradable goods, due to the increase in income, the shift in the PPF will be vertical to NT. This happens due to the fact that the boom does not change the maximum output of non-

tradable goods, ON; instead, it raises the maximum output of the tradable goods from OT to OT'. Therefore, the PPF shifts up vertically.

Figure 8.1: Spending Effect due to Resource Boom



Point A is the initial exchange rate which equals the slope of the price ratio. If the income elasticity is equal to zero, then the new point will be B. The relative price P_1 is equal to the old price ratio. At point B, there is an excess demand for N and an excess supply of T. However, at this price, the demand for N will be at point C. Moreover, at this point, there will be an excess demand for N, causing P_n to go up.

From the profit maximisation point of view, point A is no longer profit maximisation, because the new price ratio is higher than the marginal rate of transformation. The long-run analysis will be at point D, with more of N produced. In conclusion, the spending effect inevitably increases non-tradable output.

8.2.2 Resource Movement Effect

Using the same assumption of three sectors, the spending effect can be represented as:

$$Q^n = \left(\frac{q}{w}\right) = C^n(q, Y)$$

where:

w is wage rate measured in terms of tradable goods,

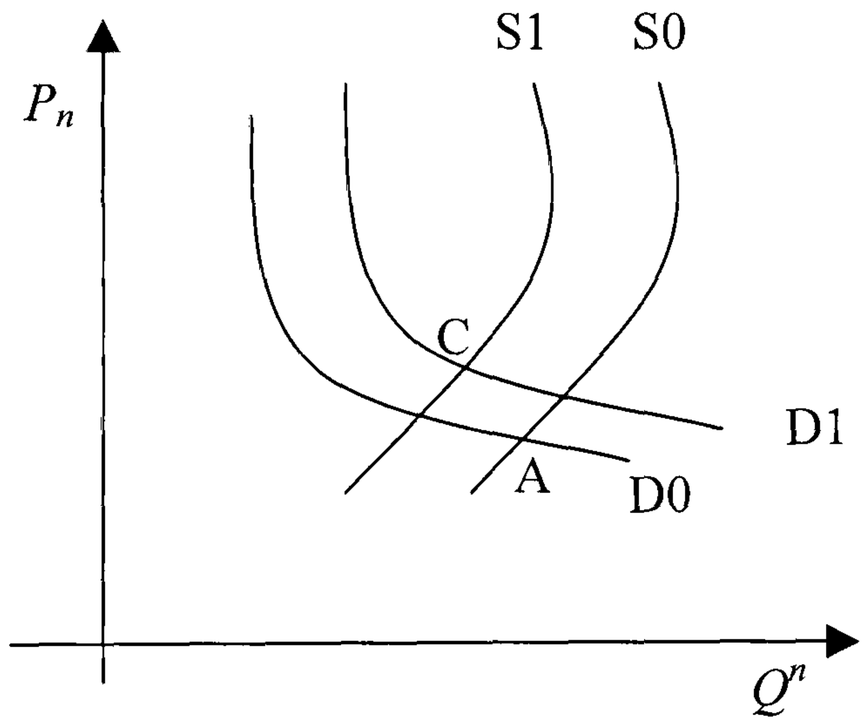
q is relative price of non-tradable to tradable goods.

The labour market equilibrium condition is satisfied so that the marginal productivity of labour in each sector is equalised. When the total labour endowment is divided between the three sectors as proposed by Corden (1984), the increase in the marginal product of labour in the booming sector B at constant wage rate w, leads to an increase in the demand for labour in B. As a result, labour will move from both tradables T and non-tradables N to B. The movement of labour from T into B lowers the output of T, causing the so-called 'de-industrialisation' or de-agriculturalisation. Given the different structures of developed and developing countries, one would expect the manufacturing sector to contract, while the agriculture sector would be most severely affected in developing countries, Benjamin et al. (1986). Accumulating both effects, resource movement and spending, further appreciation of the real exchange rate will occur. Both effects increase the relative price of non-tradable goods, pull resources from

both B and T, and as a consequence, reduce output of these sectors. Hence, T will decline, but the net effect on output in N and B is indeterminate.

As illustrated in Figure 8.2 below, Corden (1984) has explained the resource movement as follows.

Figure 8.2: Combination of Spending and Resource Movement Effects



The resource boom increases the demand for labour, causing the supply curve to shift up. Hence, the final equilibrium will be at point C. Now, if the resource movement causes the decline in N, this implies that the real wage in term of non-tradables will go up $\left(\frac{w}{p^n}\right)$ because of the rising marginal productivity in this sector. Hence, real wage w rises. The spending effect causes N to rise, leading to a decline in $\left(\frac{w}{p^n}\right)$. However, w could rise and fall. The increase in the price of N will lead to an expansion of this sector. Since the labour is the specific factor in this sector, the higher wage will attract more labour into this sector. According to

the Stopler-Samuelson theorem[15], the wage rate has to go up, and the increase in wage rate will exceed the increase in the price of N itself.

8.3 Different Variants of Core Model

In this section, we are interested in observing the different results from relaxing some of the assumptions of the basic model.

8.3.1 Decomposition of Tradable Sector

Many economists, such as Snape (1977), Corden and Neary (1982), Cassing et al. (1987) and others, have studied the impact of Dutch disease when decomposition of the tradable sector (T) is assumed. Instead of being one sector, they assumed that if the tradable sector was decomposed into many sectors. If more than one factor allowed to move, then it is quite possible that some sectors within the lagging sector will expand, in spite of the fact that the sector as a whole contracts.

In the Corden and Neary (1982) model, capital and labour are mobile among the component industries of T. Before the boom, the tradable sector constitutes a minuscule H-O economy. Then, when the boom occurs, T will release some of the globally mobile factor, labour, to other sectors, i.e., B and N. Notably, the capital in T is not globally mobile. It is only mobile among the component industries of T.

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[15]The Stopler- Samuelson theorem predicts that an increase in the price of a commodity will raise the return of the factor used more intensively in the production of this commodity and decrease the return of the factor used less intensively.

According to the Rybczynski[16] theorem, goods using labour more intensively will shrink, while those using it less intensively will expand. In other words, some of the components of T may expand, even though the aggregate T shrinks.

8.3.2 Capital is Mobile Between Tradable and Non-Tradable Sectors

Now consider that labour is mobile among all three sectors of our model, and capital is mobile only between T and N sectors which employ labour and capital in varying proportions. As in the previous situation, we have a small H-O economy. The boom causes the globally mobile factor, labour, to shift towards the booming sector. The reduction in the labour supply available to T will cause the sector using labour more intensively to shrink, while causing the other to expand. This result is induced by the resource movement effect which, in turn, is an application of the Rybczynski theorem.

If the N happens to be labour-intensive, while the T is capital-intensive, a paradoxical result is expected. This is that N will shrink, while T will expand. Therefore, the net effects on the tradable sector T can be summarised as follows. If T is labour-intensive, while N is capital-intensive, the resource movement effect with the Rybczynski effect leads to an expansion in N and a contraction in T. In addition, it results in a real depreciation of the real exchange rate which might be offset by the spending effect.

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[16] Rybczynski (1955) postulates that the growth of only one factor leads to an expansion in the output of the commodity using the growing factor more intensively and to a contraction in the output of the commodity using the growing factor less intensively, providing that the relative commodity prices are held constant.

8.3.3 Capital is Mobile Between Booming and Tradable Sectors

In this situation, we assume that capital is mobile between B and T. We maintain our assumptions of a small country and that labour is globally mobile among all three sectors. Moreover, N employs a sector-specific factor in addition to the globally mobile factor, i.e., labour. Also, as in the previous models, we assume that there are no domestic distortions and that the economy is operating at full employment with expenditure equal to income. Long (1983) has come up with three 'paradoxical' results which rely on the Rybczynski effect that give rise to supply complementarily.

(1) T may be expanding even when its price falls relative to the price of N.

(2) The expansion of T stated in (1) may be accompanied by a contraction of the output of B, relative to its pre-boom equilibrium output.

(3) The possibility of real depreciation in the exchange rate resulting from a boom in an exporting sector.

8.3.4 International Capital Mobility

This requires a dynamic model analysis of Dutch disease rather than a static model. Bruno and Sachs (1982) supposed that a rise in wealth would lead to capital accumulation in N and to decumulation in T.

Corden and Neary (1982) extended their basic model, presented earlier, to allow for some degree of international capital mobility. They consider a simple case where each of the three sectors employs sector-specific capital which, in turn, is

internationally mobile. Such capital does not, however, move among the three domestic sectors.

In order to induce international capital mobility, let us assume that the boom initially causes the rent of capital in T to decrease, while causing the rent in the other sectors to increase. Therefore, given the international capital mobility, the capital in T will flow out seeking a higher rate of return, while the capital specific to other sectors will flow from abroad to the home country. While this will reinforce the output effects, it will moderate the effects on the return to capital. 'de- industrialisation' will be greater, but the adverse effect of the boom on the profitability of T will be reduced because of the capital outflow. In the case of N, capital mobility makes the supply schedule more elastic, which in turn leads to a further rise in output. Hence, the real appreciation required to restore equilibrium would be moderated.

8.4 Limitations of Applying Dutch Disease Model to Developing Countries

Some of the assumptions that were mentioned earlier in relation to Dutch disease model need to be relaxed when they are applied to LDCs. Therefore, the model has to be modified to fit the circumstances of the LDCs.

1. Presence of Surplus Labour

The full employment assumption should be relaxed when analysing the effects of the Dutch disease in LDCs. Contrary to the majority of developed countries, LDCs have substantial underemployed and unemployment. This is due to the fact

that either many of them are engaged in low productivity subsistence agriculture or there are many job-seekers. "The concept of surplus labour pool is itself suspect; virtually no one argues any longer that LDC's contain a large group of underemployed with marginal product close to zero" (Roemer, 1985, pp. 239-240). Accordingly, each sector of the economy can draw on this pool of surplus labour without bidding away resources from other sectors. Hence, neither the resource movement nor the spending effects need occur.

However, Dutch disease was experienced in some labour-surplus developing countries such as Nigeria and Indonesia. Roemer (1985) suggested that this was due to the lack of necessary skill level required by the booming sector. Therefore, Dutch disease may occur in oil exporting LDCs, though they possess surplus labour.

2. Migrant Labour and Booming Sector

In contrast with Nigeria and Indonesia, other oil exporters and several Middle Eastern countries have welcomed large numbers of migrant labour. For instance, the migrant labour force percentage in Saudi Arabia was 60.8% of the total labour force in 1994. This situation would modify the effects of Dutch disease in two ways. Firstly, the availability of migrant labour increases the supply for all sectors of the economy, which in turn mitigates the resource movement effect. Secondly, the amount of income that migrant workers remit home or consume on imported goods or services that, by implication, take on the characteristics of traded goods, would mitigate the spending effect. As a result, the spending effect would be

moderated and the real exchange rate appreciation would reduce. For example, the outflow remittances of migrant labour were SR 57.3 billion in 1995, which accounts for 20% of Saudi Arabian oil revenues in the same year (Alhayat/Business, 2000).

However, as dependence on migrant labour grows, more non-tradable industries can be treated like other traded industries. Roemer (1985) asserted that the three-sector model collapses eventually into a traditional two-sector model with an expanding PPF due to the extra supply of labour. If B is capital-intensive while the other sector is labour-intensive, the Rybczynski theorem implies an expansion of the other traded goods sector rather than de-industrialisation. In conclusion, the spending effect is expected to be lower in migrant labour-importing LDCs relative to the developed countries.

3. Identifying Relative Factor Intensities

As stated earlier, long run effects of Dutch disease on the economy depend on the factor intensity of both T and N. However, the condition is different in the developing countries, due to the difficulty in identifying whether T or N is more capital-intensive. We cannot generalise about long-run effects because each sector is composed of sub-sectors with very different production characteristics. For instance, the tradable sector (T) includes sub-sectors which could be characterised as labour-intensive, such as agricultural exports and food production. In the mean time, T includes other sub-sectors such as manufacturing, which is probably capital-intensive. Similarly, the non-tradable sector includes capital-intensive sub-

sectors such as transport services, as well as other labour-intensive sub-sectors such as household and personal services.

4. Identifying Tradable and Non-tradable Goods

Most LDCs impose tariffs and other barriers to protect domestic infant industries. Therefore, the prices of these goods become no longer related to world prices. Hence, both tradable and non-tradable goods prices are domestically determined. In other words, government intervention eliminates foreign competition and transforms T into N. As a result, the tradable sector might expand, at least in the short run, regardless of the appreciation in the real exchange rate.

5. Imperfect Substitutions

Another reason for the difference in effects of the booming sector between developed and developing countries is the imperfect substitutions with foreign goods. Benjamin et al. (1989) analysed the impact of the oil boom on the economy of Cameroon, as a developing country. They found that some domestically produced manufactured goods were imperfectly substituted in world markets. Therefore, consumer demand did not shift entirely into foreign goods as the domestic price rises. As a result, the spending and movement effects resulting from the oil boom were moderated. This is because the prices of the imperfect substitutes were not pegged to world prices, thereby the spending effect resulting from an oil boom induced higher demand on these goods, which in turn raised their prices as well as their supply. Therefore, though T as a whole contracted,

some of the tradables sector actually expanded, due to their imperfect substitutability with foreign goods.

8.5 Dutch Disease in Saudi Arabia: Some Indicators

The purpose of this section is to study the empirical incidence of Dutch disease in Saudi Arabia. The model is based on Corden (1984) as explained earlier. In order to trace the impacts of the oil prices, an attempt is made to divide the Saudi economy into three conventional sectors, namely the booming sector (B), the tradable or lagging sector (T), and the non-tradable sector (N). The effects of the oil boom on relative price, structural change and exchange rate will be explored to see whether the predictions of Dutch disease hold in the case of a large oil producer, i.e., Saudi Arabia.

1. Booming Sector (B)

The booming sector in Saudi Arabia is, clearly, the oil sector. Despite the fall in the price of oil in recent years, the paramount position of oil in the Saudi Arabian economy remains unchallenged. Oil has been a significant factor in the development of the economy since 1970 till today, and possibly in the future. For example, between 1970 and 1995 the share of the oil sector in total real government revenues was 86%, and more than 90% of total real exports, on average. However, oil is an enclave sector with few important backward and forward linkages with other sectors of the economy, and is characterised as a capital-intensive industry.

2. Non-tradables Sector (N)

Non-tradables, broadly defined, as those goods and services that are produced and consumed domestically. In other words, non-tradable activities could be defined as those sectors which do not export or import at all, or have a negligible contribution in both total exports and imports. Looking at the components of the Saudi Arabian real GDP, one finds it difficult to separate the tradables from the non-tradables sectors. Given the above definition, services, construction and utility (electricity, gas and water) might be labelled as the non-tradables sector. Non-tradables represent on average 59% of real non-oil GDP between 1970 and 1995.

3. Tradables Sector (T)

By definition, tradables include those goods which are actually traded, as well as those which are potentially traded. Tradables are derived residually, i.e., the remaining sectors after excluding booming sector and non-tradables. Therefore, agriculture, manufacturing and non-oil minerals are labelled as the tradables sector. Tradables' contribution to real non-oil GDP over the period 1970-1995 was 41% on average.

Table 8.1: Booming, Tradables and Non-tradables in Saudi Arabian Economy (1970-1995)

(Yearly Average, constant SR)

Booming Sector (B) Oil	Output % in (B)	Tradables Sector (T)	Output % in (T)	Non-Tradables Sector (N)	Output % in (N)
-Mining of Crude oil and Natural Gas	91.7	Agriculture	55.7	Services	70.6
-Petroleum Refining	7.1	Manufacturing	40.8	Construction	21.2
-Construction Associated with Oil Sector	1.2	Non-oil Minerals	3.5	Electricity, Gas and Water	5.2

Source: Author's classification.

8.5.1 Relative Prices of Non-tradables to Tradables $\left(\frac{p_n}{p_t}\right)$

Saudi Arabia is deemed to be a small, open economy, and that as such it is a price taker in international markets. The domestic price level is determined according to the supply and the demand conditions. The oil boom has resulted in an increase in the price of non-tradables at a higher rate relative to the price of tradables. Because good data are not available on a relative price, proxies should be used. Thus, the analysis used here in order to calculate the relative prices was as follows. First, for each year between 1970 and 1995, the price index of tradables P_t was estimated by dividing the sum of GDP deflators of all the components of the tradables sector, given in Table 8.1, by the sum of the implicit non-oil GDP deflator of the same components. Second, using the components of the non-tradables sector, the price index of non-tradables P_n was estimated in the same way. Finally, the relative price index of non-tradables to tradables was calculated by dividing the estimated price index of non-tradables by the estimated price index of tradables and multiplying the result by 100. Table 8.2 gives the index of relative prices of non-tradables to tradables.

The prediction of Dutch disease is that the oil boom would have a great effect on relative prices. Table 8.2 reveals that the price index for the non-tradables continuously increased throughout the 1970-1978 period. Since 1979, it has been decreasing. Moreover, the average inflation rate in the non-tradables sector was higher than the average inflation rate in the tradables sector throughout the 1971-1976 period. Afterwards, it stabilised. The movements in the relative prices did

not change noticeably 1970-1973. The ratio increased from 123.8 in 1973 to 148.0 in 1974, which represents a percentage change of 19.6%.

Table 8.2: Tradables and Non-tradables Deflators for Saudi Arabia (1970-1995)

Year	Tradables (P_t)	Inflation in (P_t)	Non-tradables (P_n)	Inflation in (P_n)	$\left(\frac{P_n}{P_t}\right)*100$	Real Exchange Rate change (%)
1970	99.94		102.78		102.84	
1971	100.79	0.9	105.02	2.2	104.20	1.32
1972	104.59	3.8	118.78	13.1	113.57	8.99
1973	112.00	07.1	138.62	16.7	123.76	8.97
1974	164.73	47.1	243.85	75.9	148.03	19.61
1975	200.51	21.7	348.28	42.8	173.70	17.34
1976	242.50	20.9	425.52	22.2	175.47	1.02
1977	329.31	35.8	461.68	8.5	140.20	-20.10
1978	355.44	7.9	487.19	5.5	137.07	-2.23
1979	384.47	8.2	522.45	7.2	135.89	-0.86
1980	416.48	8.3	540.36	3.4	129.74	-4.52
1981	442.18	6.2	560.58	3.7	126.78	-2.29
1982	469.77	6.2	556.72	-0.7	118.51	-6.52
1983	466.06	-0.8	546.92	-1.8	117.35	-0.98
1984	466.27	0.0	558.93	2.2	119.87	2.15
1985	463.85	-0.5	549.57	-1.7	118.48	-1.16
1986	460.09	-0.8	538.51	-2.0	117.04	-1.21
1987	457.83	-0.5	531.56	-1.3	116.10	-0.81
1988	469.49	2.5	533.28	0.3	113.59	-2.17
1989	477.58	1.7	536.89	0.7	112.42	-1.03
1990	494.53	3.5	552.79	3.0	111.78	-0.56
1991	543.40	9.9	583.05	05.5	107.30	-4.01
1992	571.47	5.2	604.38	3.7	105.76	-1.43
1993	596.44	4.4	622.33	3.0	104.34	-1.34
1994	619.83	3.9	636.64	2.3	102.71	-1.56
1995	640.93	3.4	642.38	0.9	100.23	-2.42

Source: Author's calculation based on SAMA (1998).

The index of relative prices peaked in 1976 at 175.5. The appreciation of the relative price (real exchange rate) was experienced throughout the period 1970 to 1976. However, after 1976, the real exchange rate levelled off and started to decrease, i.e., depreciation of the real exchange rate. This resulted in a rapid

growth rate of tradable goods, particularly in 1976, when the rate exceeded 21% in nominal terms. This could be attributed to the fact that the continuous rigidity of the relative prices led the government to respond mainly by subsidising the tradables.

8.5.2 Exchange Rate

Explaining how export booms affect a country's real exchange rate, and how the real exchange rate, in turn, affects other industries are important and integral points in understanding the Dutch disease phenomenon. Consider that an export boom leads to the accumulation of foreign exchange reserves and hence, ceteris paribus, an appreciation of the real exchange rate. Let the real exchange rate (RER) be defined here as the foreign currency price of a unit of domestic currency (that is nominal exchange rate) multiplied by the ratio of the domestic to the foreign price level.

$$RER = R_0 \frac{P_w}{P_d}$$

where:

R_0 is an index of the nominal exchange rate defined as number of units of local currency per unit of foreign currency;

P_w is an index of tradables' prices determined by the world's price in the case of a small, open economy like Saudi Arabia, i.e., Saudi Arabia price level;

P_d is an index of domestic price, e.g., wholesale or consumer price index (CPI), i.e., foreign price level.

The domestic price of tradable goods is given by P_d. Now, changes in P_d will reflect changes in the domestic price of non-tradable goods. P_d acts as a proxy for domestic inflation. An increase in P_d, holding P_w and R_0 constant, leads to a decline in the RER. This decline called an appreciation of the real exchange rate. Similarly, for fixed P_w and P_d, a decline in R_0 leads to an initial appreciation of the real exchange rate. The final change in the RER is a function of how P_d will respond to the change in R_0.

The real exchange rate appreciation (depreciation) adversely affects the competitive position of an individual exporting (import-competing) firm in a country, assuming that the world demand for oil is relatively inelastic. For other commodities whose world markets are perfectly competitive, unlike OPEC, an appreciation of the RER leads to increase in the relative price of exportables. This provokes a decrease in the relative price of importables, and thus causes a fall in exports and an increase in imports. It is this loss of export competitiveness which drives the phenomenon of Dutch disease.

Before 1975, the exchange rate of the Saudi Arabian riyal was linked with the US dollar. Throughout the entire decade of the 1960s, the value of the riyal remained stable in relation to the US dollar. However, when the dollar weakened in the early 1970s, the riyal tended to appreciate against the dollar, with its exchange rate rising by a total of 27%. The strong foreign exchange position of Saudi Arabia appreciated the riyal from SR 4.50 to SR 3.55 per dollar over a period of less than 2 years, that is from December 1971 to August 1973. The continuing

depreciation of the dollar led the Saudi Arabian government to sever the link of the riyal with the dollar in 1975. In order to stabilise the riyal, Saudi government pegged the riyal to the Special Drawing Rights (SDR) in 1975. The stabilisation arrangement was based on pegging to SDR at SR 4.28255 = SDR 1, with margins of 7.25% on either side of the parity. This policy, was justified by the Saudi Arabian government, on the basis that pegging the riyal to one currency was not desirable, and pegging to a basket of currencies was perferable. The Saudi government desired to prevent the riyal from being adversely affected by erratic movements in the exchange rates of major currencies due to international speculative forces having no relationship with the domestic economy. The utilisation of wider margins was also advocated on the basis that it would help to insulate the riyal from excessive and undesirable movements in the SDR itself due to unhealthy speculative forces conflicting with the welfare and growth-oriented strategies of the Saudi Arabian government. The consequence of such pegging was expected to be less variation in the exchange rate and the prices of import, and hence, less variation in inflation (SAMA, 1998).

This policy did not last for long, as the Saudi Arabian government decided to abandon linking the riyal to the SDR and return to linking it to the dollar in 1981. The officially announced reason was the substantial exchange rate appreciation of the riyal against SDR, as a consequence of which the margins with SDR were suspended. In fact, the US dollar remained the intervention currency, and the riyal/US dollar continued to serve as the basis for other exchange quotations in the market in the period 1975-1981. There were several reasons for this policy of

pegging the riyal to the US dollar. Firstly, the oil revenues which accrued to the government were denominated in US dollars. Therefore, these revenues would be exchanged for riyals, which would make it easier for the government in planning the annual budget. Secondly, Saudi Arabia is an open economy, and imports played a major role in the trade sector. A stable relationship between the riyal and dollar would lead to stable prices of imports from the major countries which traded with Saudi Arabia, such as the US and other developed countries. Finally, a large proportion of Saudi investment was either inside the United States or in assets dominated by US dollars.

Although the nominal exchange rate was not altered, it changed from one period to another to reflect the change in the inflation rate. For instance the nominal exchange rate in the period 1970-1980 appreciated, reaching its peak in 1980. After 1980, however, the nominal exchange rate of the riyal showed continuous depression, probably induced by the decline of oil prices. From 1987 onwards, the nominal exchange rate was fixed against the dollar, due to the new government arrangement which maintained the parity at SR 3.745 per US dollar.

8.5.3 Structural Change

Compared to relative prices and the exchange rate, the oil boom has a clearer impact when it comes to structural change. The relative price and the attraction of the booming sector to mobile factors together play a major role when a small economy increases absorption in response to windfall gains. Holding the assumption of full employment equilibrium, the mechanism of relative prices' operation in an economy could be explained as follows. Since the price of

tradables has not changed, their excess demands can easily be satisfied through additional imports. On the other hand, the excess demand on non-tradables, together with the rise in the cost of production and income effects, will cause domestic inflation. As domestic inflation soars, the non-tradables expand at the expense of tradables outputs. This effect is the key source of the decline in non-oil tradables production and export.

Table 8.3: Sectoral Composition of Output: Percentage of Tradables and Non-Tradables Sectors Real GDP

(Constant 1970 Prices)

Sector	Boom Period (1970-1982)				Post-Boom Period (1983-1995)			
	1970	1982	% Change	Annual Growth Rate	1983	1995	% Change	Annual Growth Rate
Tradables	42.67	39.19	-3.48	9.3	39.23	41.57	2.34	0.02
Agriculture	65.64	44.84	-20.8	5.9	45.08	59.46	14.38	0.03
Manufacturing	31.21	50.93	19.72	13.9	51.25	38.52	-12.73	0.03
Non-oil Minerals	3.16	4.23	1.07	13.7	3.67	2.02	-1.65	0.55
Non-tradables	57.33	60.81	3.48	10.7	60.77	58.43	-2.43	0.01

Source: Author's calculations based on SAMA (1998).

If we look at the sectoral growth rates given in Table 8.3, and Figures 8.1 and 8.2, we can see that during the boom period, at the aggregate level, the non-tradables sector in Saudi Arabia was growing faster than tradables. In the former case, the annual growth rate was 10.7%, whereas for the latter it was only 9.3%. According to the above analysis, and based on the assumption that the increase in relative prices of non-tradables to tradables had actually led to an increase in the profitability of the former relative to the latter, it can be argued that more investment was attracted to non-tradables, a fact that explains its higher growth.

Figure 8.3: Real Rates of Growth of Economic Sectors

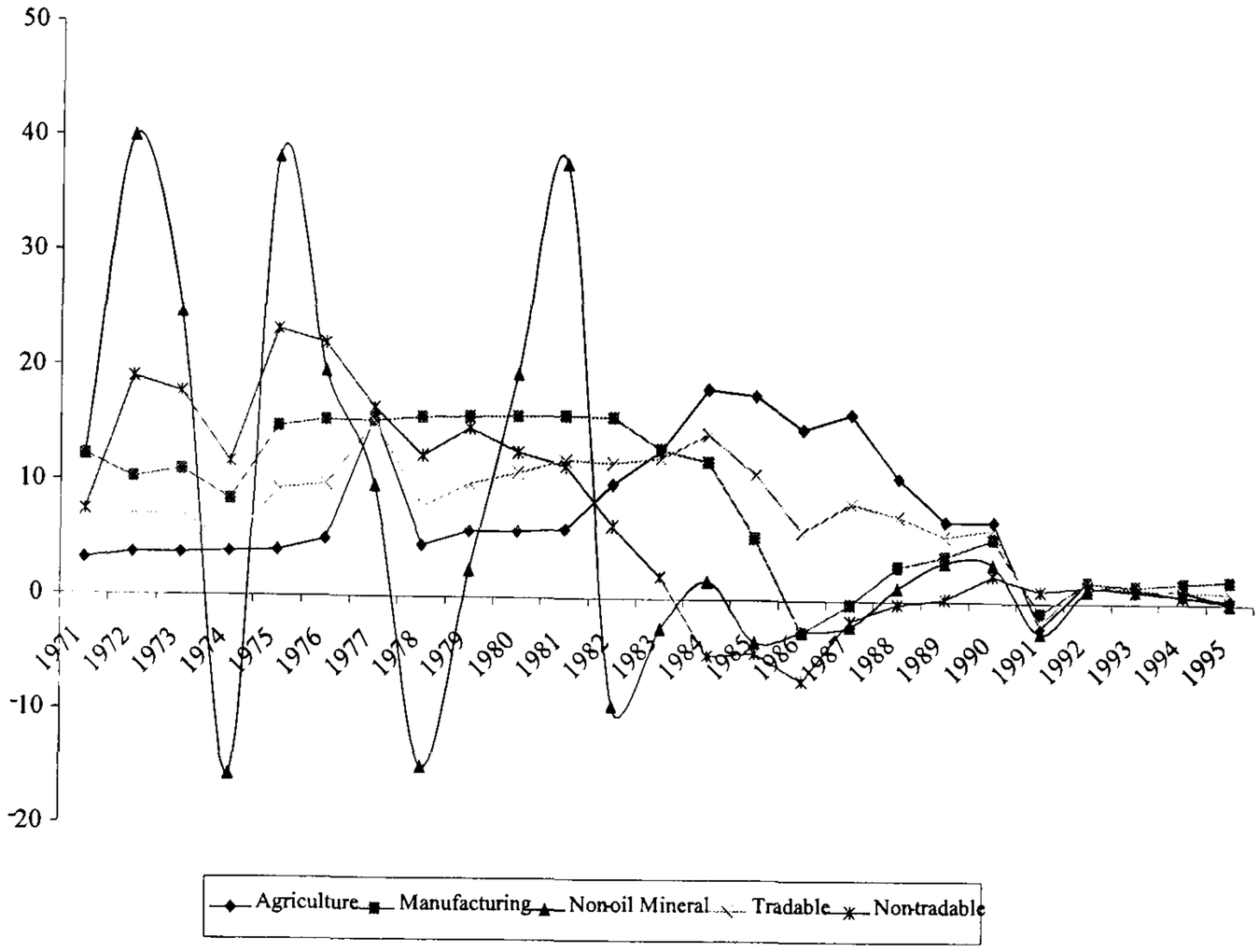
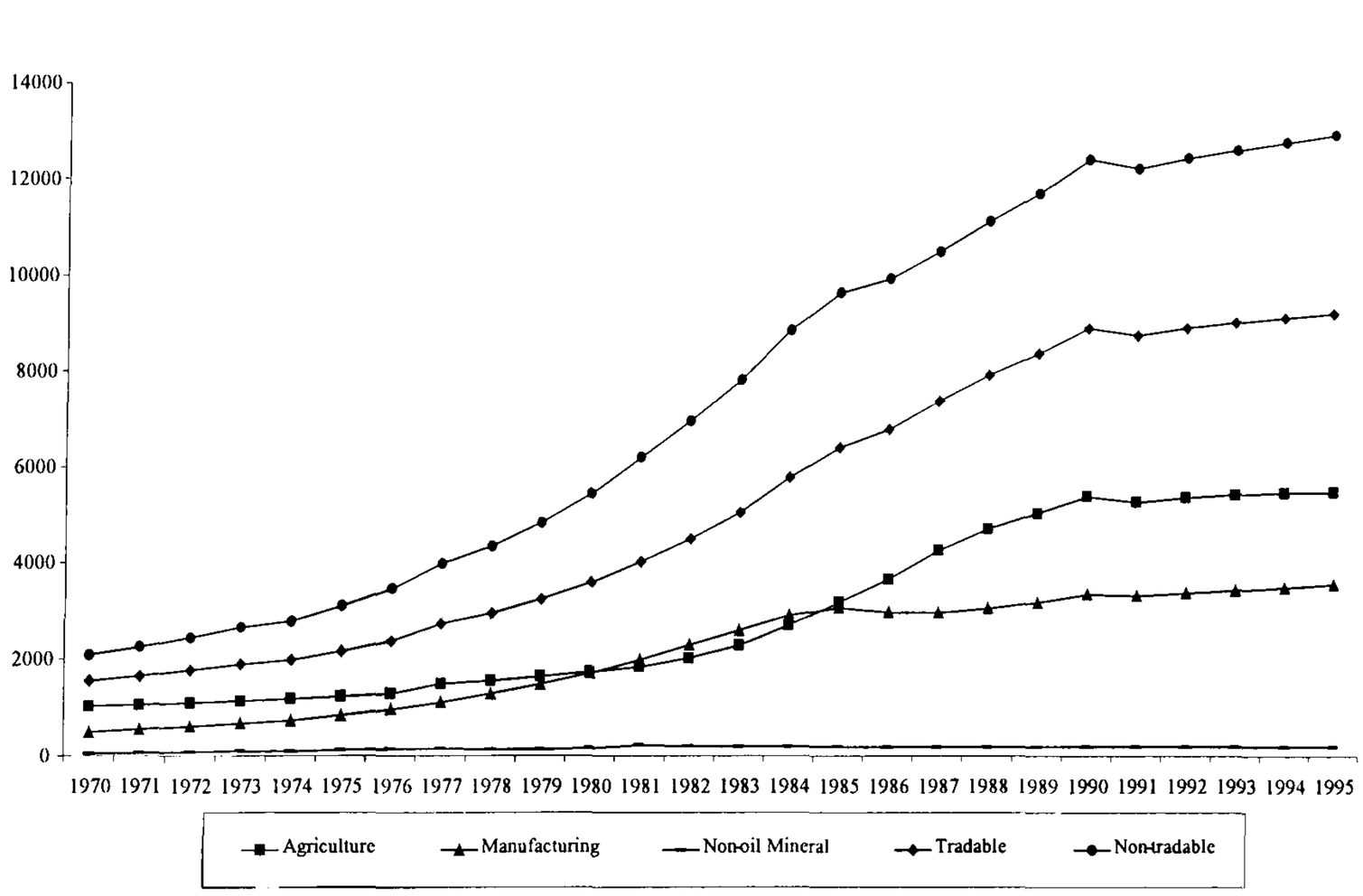


Figure 8.4: Real Non-Oil GDP by Sector



During the boom period, on an aggregate basis, the tradables sector was declining in terms of its share in non-oil GDP. However, within tradables themselves, at a more disaggregated level, matters were not the same. Indeed, the manufacturing

sector was not declining; rather, its share in real non-oil GDP increased from 31.2% in 1970 to 50.9% in 1982, and over the same period it recorded remarkable annual growth rate of 19.7% in real terms. Similarly, the non-oil minerals sector experienced a slight increase in its share of real non-oil GDP, from 3.2% in 1970 to 4.2%, and over the same period it recorded annual growth of 1.1% in real terms.

On the other hand, the annual growth rate of the agriculture sector was lower than that of manufacturing and non-oil minerals, and in terms of its contribution to real non-oil GDP, the sector recorded a percentage decrease of 20.8%; that is, from 65.6% in 1970 to 44.8% in 1982. Therefore, during the boom period, Saudi Arabia experienced de-agriculturalisation rather than de-industrialisation. This stems in part from the fact that Saudi Arabia had negligible industrial output before the 1973-74 oil boom, and was not an exporter of industrial products. Another reason for the slower growth in agriculture compared to manufacturing was due to the government policy of investing heavily in manufacturing at the expense of agriculture. Although the share of the agriculture sector declined in the booming period, its annual growth rate was increasing over the same period. The average annual growth rate of agriculture was about 6%. This growth can be attributed to the role of government subsidy, and the direct agricultural price support.

Indeed, Table 8.4, which gives the composition of both public and private investment by sector, clearly indicates that during the boom period, investment was concentrated in manufacturing and non-tradables, at the expense of

agriculture and non-oil minerals. During the same period, the annual growth rate of non-tradables was higher than that of tradables; that is, 10.7% compared to 9.3%. In terms of contribution to real non-oil GDP, non-tradables increased their share from 57.3% in 1970 to 60.8% in 1982. This increase is due to the high percentage of investment in the non-tradable sector, especially in social infrastructure.

Table 8.4: Composition of Lending by Sector (%)

Sector	Booming Period Loan (1970-1982)		Post-boom Period Loan (1983-1995)	
	Government Institutions	Commercial Banks	Government Institutions	Commercial Banks
Agriculture (Tradable)	4.00	1.68	7.69	4.51
Manufacturing (Tradable)	42.81	23.02	38.35	20.89
Non-oil Minerals (Tradable)	5.41	3.34	2.99	1.45
Non-tradable	47.77	71.96	50.96	74.15

Source: Ministry of Planning (1999).

During the post-boom period, the share of investment in non-tradables increased, in spite of the fact that relative prices of non-tradables to tradables declined. This is an indication that price changes are not necessarily important in determining the direction of government investment. Indeed, the direction and amount of Saudi Arabian government investment appropriated to the different economic sectors depended to a large extent on the government's development policy. The government's desire was to satisfy the social needs of its people and to implement its long-run goal of creating an alternative source of foreign exchange.

If this was a reasonable justification for the public to increase their investment, regardless of factors such as sales and profits which affect investment and its direction, how can we justify this for the commercial banks? Before trying to answer this question, it is necessary to explain the role of the commercial banks in financing economic development in Saudi Arabia. During the boom period, their role were negligible. According to Al-Ali (1992), there were two reasons for this: First, the huge increase in the level of government expenditure led to an increase in private sector income, hence the increase in private sector liquidity. As a result, the private sector businesses were able to self-finance their investments without the need for bank loans. Secondly, the availability of low-cost loans from the public specialised funding institutions. During the post-boom, however, the above situation was reversed, and the demand for loans increased. Notably, most of the commercial loans were to finance foreign trade transactions of the private sector.

Table 8.5: Composition of Public Subsidies by Sector (%)

Sector	Booming Period Subsidies (1970-1982)	Post-boom Period Subsidies (1983-1995)
Agriculture (Tradable)	132.5	1.84
Manufacturing (Tradable)	-	-
Non-oil Minerals (Tradable)	-	-
Non-tradable	139.33	-1.54

Source: Ministry of Planning (1999).

Table 8.5 shows that during the same period, the share of non-tradables as a whole in non-oil GDP declined, in spite of the fact that the share of investment in non-tradables increased. As far as the tradable sector is concerned, even though as a

whole it expanded its share in real non-oil GDP, the non-oil minerals and manufacturing sectors declined both in terms of their share in non-oil GDP and their annual growth rate. On the other hand, the agriculture sector increased its share in non-oil GDP with slower annual growth rate of only 0.03%. The relatively slow contraction of agriculture compared to manufacturing and non-oil minerals is largely due to the government policy on subsidies, with a lower percentage during the post-boom period.

According to the Dutch disease model, a resource boom will lead to an increase in relative prices of non-tradables to tradables (positive relationship), which in turn will lead to a decrease in the tradables sector (negative relationship). In order to test empirically whether these relationships or associations hold in the case of Saudi Arabia, we estimated the correlation matrices of variables given below. Each correlation matrix of variables contains the correlation coefficients between the oil price (OP) and relative prices of non-tradables to tradables (RP) on the one hand, and the shares in non-oil sector real GDP of non-tradables (%N), tradables (%T), agriculture (%AG), manufacturing (M), and non-oil minerals (NM), on the other. The correlation matrices were estimated for the boom period (1970-1982), the post-boom period (1983-1995), and the sample period as a whole (1970-1995). According to the above analysis, the expected signs are as follows.

	%N	%T	%A	%M	%NM	OP	RP
OP	+	-	?	?	?	+	+
RP	+	-	?	?	?	+	+

As the results of the estimation show, all the signs are as expected during all three periods, even though the correlation coefficient is low in some cases. Therefore, it has been shown once more that, on an aggregate basis, the case of Saudi Arabia is in close conformity with the predictions of Dutch disease theory.

Figure 8.5: Estimated Correlation Matrix of Variables (1970-1982)

	%N	%T	%A	%M	%NM	OP	RP
OP	0.97	-0.97	-0.97	0.98	0.17	1	0.34
RP	0.33	-0.33	-0.33	0.31	0.67	1	1

Figure 8.6: Estimated Correlation Matrix of Variables (1983-1995)

	%N	%T	%A	%M	%NM	OP	RP
OP	0.79	-0.79	-0.79	0.78	0.81	1	0.49
RP	0.73	-0.73	-0.73	0.73	0.74	0.49	1

Figure 8.7: Estimated Correlation Matrix of Variables (1970-1995)

	%N	%T	%A	%M	%NM	OP	RP
OP	0.62	-0.62	-0.62	0.78	-0.23	1	0.07
RP	0.65	-0.65	-0.65	0.36	0.83	0.07	1

8.6 Policy Response

The impact of the resource boom could have been more harmful to the economy, if the Saudi Arabian government had not intervened to moderate its full effects. The government adopted some short-term policies to mitigate the structural effects caused by the disease. However, some of these policies had side effects on the economy. In the next section, we are interested in introducing and analysing these policies in order to establish a long-term policy to protect the Saudi Arabian

economy and specifically, the growth in non-oil minerals, from the symptoms of Dutch disease.

Firstly, the Saudi government used a substantial proportion of the oil revenue to subsidise the production of the tradables sector, especially agriculture and manufacturing industries. Nevertheless, such a policy reduced the boom resource, not without excess burdens to the society, because these goods were valued less than the marginal social costs of production. Secondly, it imposed tariffs and barriers on some import-competing tradables industries. Regardless of the limited advantage which may be gained by the domestic producers, such a policy makes the society as a whole worse off, because the insufficient producers over-produce and consumers under-consume. Thirdly, in order to reduce the growth constraint of the tradables sector, Saudi Arabia imported a large amount of capital, such as machines and equipment. The increase in the supply of capital moderated the resource movement effect and, on the other hand, the payments for the purchases of these machines reduced the spending effect. Therefore, the real exchange rate appreciation and the structural effects were both mitigated.

Although the Saudi government exerted efforts to mitigate the problem of Dutch disease, it still exists. This is because its interventions to stabilise the effects of the resource boom (through government expenditure) were intended for the symptoms rather than the causes. As regards the non-oil minerals sector, with which we are primarily concerned, the government will need to protect the sector from the adverse effects of the oil boom. Furthermore, they need to ensure that the

rest of the economy is insulated as much as possible from the harmful economic impacts of a resource boom.

There are several measures that can be taken to protect the tradables sector. They include devaluation, anti-absorption, and capital accumulation policies. The objective of a devaluation policy is to improve the balance of payments. As a result, the income effects of the devaluing country will have two important roles. Firstly, this income effect is associated with the rise in export earnings which will improve domestic demand operating through the multiplier effects. Secondly, the income effect has an impact on the terms of trade. As a consequence of devaluation, it is expected that the export price will fall relative to import price. However, one should be careful in prescribing a devaluation policy, because of the future problems that accompany it, such as inflation.

An alternative policy could be the anti-absorption method. This method involves tightening credit for consumption and investment, in other words, slower depletion of oil resources and more investment abroad in order to stabilise the exchange rate. However, this issue has received a controversial response in most of the Saudi Arabian economics literature. Such a policy was in fact used by the Saudi Arabian government when it decided to invest part of the Saudi Arabian oil revenues abroad. The officially announced reason was to provide income when oil exports decline, and prevent excessive appreciation of the Saudi Arabian currency. Opponents argue that while this kind of policy mitigates the appreciation of the real exchange rate, the rate of return on such investment has

been far less than would have been achieved by leaving the oil in the ground. On the other hand, the supporters are arguing from a long-term point of view. They believe that transforming the oil into overseas assets was better than transforming it into imports which could not have been sustained, and hence would have generated future inflation and unemployment. Finally, it should be borne in mind that an anti-absorption policy may not, in any case, be applicable in the case of Saudi Arabia, as Alexander (1952) argues that this policy is preferable only as full employment is approached.

The other available policy alternative is the positive use of the accumulated assets to promote non-oil mineral development. This could be achieved through the use of assets to import capital equipment which would strengthen the industrial base and sustain the economic development, particularly when the resource runs out.

8.7 Conclusion

We have seen in this chapter that according to Dutch disease theory, a boom in one of the sectors of the economy is not only a blessing, and may lead to de-industrialisation or/and de-agriculturalisation. This phenomenon is called Dutch disease, after it was observed in the Netherlands in the 1970s when the flow of North Sea gas increased sharply. There are two basic mechanisms that bring about such negative effects, the spending effect and the resource movement effect.

Contrary to the Dutch disease symptoms (in the form of a contraction in the tradables sector) observed in the Netherlands and other developed countries, the

manufacturing sector actually expanded at the expense of agriculture in most oil-exporting developing countries, including Saudi Arabia, following the oil boom of the 1970s. In the non-oil minerals sector, the same observation, though with less degree of expansion, was obtained. We have seen that there is no unanimous agreement among economists as to why the manufacturing sector expanded in these countries. With regard to the Saudi Arabian case, our empirical study suggests that aspects of Dutch disease syndrome are observed. Using correlation analysis, we have seen that the massive oil export price increase in the boom period led to an increase in relative prices of non-tradables to tradables, an expansion in the share of non-tradables in non-oil GDP, and a contraction in the share of tradables. Within the tradables themselves, it was the agriculture sector which suffered most, unlike manufacturing and non-oil minerals, whose shares actually expanded during the boom period. This could be explained by the fact that Saudi Arabia had negligible industrial output before the 1973-74 oil boom, and was not an exporter of industrial products.

However, the equilibrating role of relative price changes in the economy structure does not necessarily operate in the case of Saudi Arabia, due to the fact that price levels are not an important mechanism for clearing markets. This is because of the dominance of government investment, which was influenced more by the government development strategy than by relative price and profitability changes. During the post-boom, when the Saudi Arabian oil price witnessed a massive decrease, the Dutch disease syndrome reversed itself in Saudi Arabia, leading to results opposite to those observed during the boom period. The oil decline is

expected to cause an expansion in the tradables sector and a relative contraction in the non-tradables sector. However, the adjustment process may take time, due to the higher cost of the re-entry into tradables industries.

Some economists do not consider Dutch disease a problem unless it accompanies any kind of economic distortions or externalities. They believe that in the presence of any kind of economic externalities, an export boom could induce adverse welfare effects. For instance, since a temporary resource boom crowds out the tradables sector, it delays the learning-by-doing experience that improves the comparative advantage in the production of tradable goods. Therefore, the non-oil GDP has to grow by itself and independent of oil revenues in order to diversify the country's economy, and sustain and accelerate its growth rate.

Chapter 9: Summary and Conclusions

The oil sector is the major pillar of the Saudi Arabian economy. Since the beginning of first Five-Year Development Plan in 1970, the Saudi Arabian economy has relied heavily on oil. The Saudi Arabian economy is dependent on oil exports, such that a slight decline in oil exports has a heavy impact on the macroeconomy of the country. As a result, the Saudi Arabian government realised that it would be beneficial for the economy to utilise its oil income by investing in other productive sectors, such as manufacturing, agriculture and, more recently, the non-oil minerals sector, in order to diversify its economic base before oil is depleted.

The aim of this study has been to evaluate the contribution of the non-oil minerals sector to the economic growth of Saudi Arabia during the period 1970-1995, as well as to investigate the new Saudi Arabian policy of promoting the non-oil minerals sector as a means to diversify the economy away from oil.

9.1 Conclusions

We have shown in Chapter Two of this study that, before the discovery of oil in the 1950s, the Saudi Arabian economy relied mainly on agriculture and the revenue from pilgrims in the two holy cities, Makkah and Madinah. The Saudi Arabian development strategy in its first phase (1970-1985) was to consolidate the massive inflow of oil revenues to build the infrastructure and raise the living standard of the Saudi citizens. This phase, known as the oil boom period,

experienced an expansion in the industrial sector, construction, infrastructure and transport, and several pipeline projects grew rapidly to facilitate the sale of oil. The huge government expenditure and the pace of development led to high inflation and increased the number of foreign workers. The government managed to reduce the rate of inflation by adopting some fiscal and monetary controls, such as cutting expenditures and controlling the money supply. Moreover, the government had to act on the problems of a shortage in local manpower and the increased numbers of foreign skilled and unskilled labour. Foreign labour was needed to run many economic activities and was seen as a partial solution to the lack of local workers. The second solution was, however, to increase the number of educational and vocational institutions for Saudi citizens to increase their ability to carry out the development process in the country. This policy succeed in replacing foreign white collar workers with local ones, but it failed in terms of the replacement of blue collar workers.

The second phase was shaped by the oil price crash in 1986. The major source of income for the Saudi Arabian economy was affected badly by the drastic decline in oil prices. The government responded by cutting spending, delaying projects, ending subsidies, and depleting its foreign assets. As a result, economic growth slowed down, many companies were bankrupted, and the commercial banks experienced an increase in debt. The non-oil sector was unable to offset the decline in the role of oil and stimulate economic growth. The Saudi planners adopted two policies to boost the non-oil sector in order to diversify the economy away from oil as the main source of foreign exchange. Firstly they encouraged the

commercial banks to replace the government as the main source of funds to the private sector. Secondly, they imposed tariffs and imports restrictions to protect local industries. The oil sector, meanwhile, experienced an expansion in production capacity, as well as in both downstream and upstream projects. By the end of the second phase in 1989, the above policies coupled with an increase in the oil prices had fostered Saudi economic growth.

The Gulf War marked the beginning of the third phase the third phase and halted that economic growth. The Iraqi invasion of Kuwait in 1990 led to a huge money outflow from the Saudi commercial banks. SAMA played a major role in restoring the confidence of both foreign and domestic creditors. Saudi Arabia increased oil production to offset the loss in the market caused by the UN embargo on both Iraqi and Kuwaiti oil exports. The cost of the Gulf War led to a record budget deficit in absolute terms in 1990/1991. As a result, the government responded by drawing down further external assets, increasing its bond sales, and for the first time, external borrowing. In contrast, the private sector benefited from the government's massive spending on the allied troops, as well as the cutting of some utilities' prices.

Chapter Three was devoted to examining the Saudi Arabian industrialisation strategy. Industrialisation was perceived by Saudi Arabian planners as a means of diversifying the economy away from crude oil as a major source of income and foreign exchange earnings. Moreover, industrialisation was seen as a long-term structural change in the non-oil sector production in order to reduce dependency

on crude oil and imported goods, to create income stability and, more important, to create integration among local industries. The Saudi planners recognised the limitations of oil as an enclave sector, with exhaustible resources, and volatile prices. Given the shortage of local labour, and limitations of domestic market, the new industries were selected to be capital-intensive as well as export-oriented. Hydrocarbons industries, such as oil refineries and petrochemicals, would ensure that Saudi Arabia was competitive in world markets by using crude oil and natural gas as cheap feedstock. The government, by means of subsidies and tariffs protection, encouraged the private sector to invest in import substitution industries. Despite the country's arid environment, the Saudi agriculture sector had grown rapidly. However, the government incentive programmes and protectionist trade policies were costly and unjustified. Therefore, the extreme environment as well as the cutting of government subsidies put an end to any further growth in the agriculture sector. After two decades of development, the role of the non-oil sector in Saudi Arabian economic growth remained relatively weak.

Chapter Four of this study served as a general background to the Saudi Arabian non-oil minerals sector. The production, potential, and structure of the industries in this sector were presented. It was shown that the non-oil sector had so far made a poor contribution to the Saudi economy. Despite the presence of large non-oil mineral commodities, the sector had done very little impact in terms of macroeconomic measures. This was due to many reasons, among them, the relatively low investment (government and private) and poor infrastructure, which

were inadequate to reduce the exploitation cost and the negative effect of the oil sector on the whole non-oil sector. In its commitment to diversify the economy, Saudi Arabia has recently, launched an ambitious plan to develop the non-oil minerals sector. Supported by the discovery of huge reserves of several non-oil mineral commodities, the Saudi planners believed that the sector could play a major role in the diversification of the economy. Non-oil mineral goods (as well as the rest of non-oil goods) were expected to reduce the Saudi Arabian export instability. Moreover, the sector could integrate with other sectors inside the domestic economy by developing more backward and forward industries. Four significant steps initiated by the government (within less than three years), reflecting the strong commitment to promote the non-oil sector. The first step was the announcement of the formation of the Supreme Petroleum and Mineral Affairs Council (SPMAC), headed by the Saudi Crown Prince. The second was the establishment of the state-owned Ma'aden, which will consolidate all mining projects in which the government is involved, with an initial capital of more than SR 3.7 billion. The third move was the revision of the country's mining investment laws to attract more local and foreign investors. And last, but not least, was the establishment of the Saudi Geological Survey (SGS) as an independent organisation to provide accurate information in the non-oil minerals' field. The impacts of such incentives for the sector were significant. Ma'aden initiated new mining projects and expanded the already existing mines. However, the full impacts on the sector, as well as on the Saudi economy as a whole, will take some times to be manifested.

A portfolio model was employed in Chapter Five to address the problem of Saudi Arabian export instability. The chapter discussed how uncertainty would influence economic behaviour adversely. Therefore, diversification in international trade has become a goal for Saudi planners in the past two decades. The objectives of this chapter were to investigate the relationship between the Saudi Arabian increased diversity and export performance, and to examine marginal changes in the Saudi export portfolio. Aiming to provide guidance to the Saudi planners, the most non-oil export commodities were used in the portfolio model for two distinct periods, 1984-1990 and 1991-2000. It was found that there is a tenuous relationship between the Saudi increased export diversity and export earnings, which is consistent with a number of other studies (MacBean and Nguyen, 1980; Love, 1983; Alwang and Siegel, 1991). Evidence was presented that, during both periods, machinery and transport equipment ranked best in terms of international price trends and the impact of their exports on earning stability. It was also found that there is inconsistency in the impacts of changes in commodity volume on stability and earnings' growth from period to period. Commodities' impacts on instability or earnings changed dramatically from one period to the next. Thus, the design of 'optimal' adjustments in the export portfolio is complicated. If it may be assumed that price trends can be forecasted more accurately than variability in earnings, then it is wiser to choose changes in the export portfolio based on expected earnings.

Chapter Six of the thesis was devoted to an application of the input-output model in order to estimate and evaluate, first, the inter-industry linkages of the non-oil

minerals sector with the rest of the sectors, and second, the economic multipliers (output, foreign exchange earnings, imports, income and employment) generated by the non-oil sector and the other sectors of the economy. Using the 1994 Saudi Arabian input-output table, the results of the estimation show that the non-oil minerals sector possesses relatively low backward and forward linkages. Moreover, these linkages are developed only within the sector itself and with a few other sectors, as indicated by the high coefficients of variation of those linkages. In addition, the estimation of the economic multipliers has shown that, apart from the exports' multiplier, the sector had insignificant impacts on the economy. However, when induced impact is included, the sector reveals relatively high income and employment multipliers. This indicates that the non-oil minerals sector can be stimulated by an increase in final demand, and generate more income and employees than other sectors of the economy. Therefore, it is expected that the impact of expansion and/or an introduction of a new industry within the non-oil minerals sector would have significant effects on the Saudi Arabian economy. It has also been shown empirically that the oil sector did not constitute a key sector. The sector loses its key sector status when the coefficients of variation of its linkages are taken into account. The sector which we identified as the key sector in the Saudi Arabian economy in 1994 was the manufacturing sector, which seemed to offer maximum effects on all the policy objectives under consideration.

Chapter Seven was rather an extension and complement of the estimation in the previous chapter. The high income and employment multipliers in the non-oil

minerals sector in 1994 had suggested that an increase in final demand would stimulate the sector. Therefore, we were interested, in this chapter, to examine the effects of an expansion within the non-oil minerals sector resulting from changes in the final demand for that sector products. Specifically, this involved an empirical application of an input-output approach to the analysis of the economic impacts of the introduction of three new industries. These were aluminium, phosphate, and iron. Quantitative results were presented, in terms of projected industry output, household income and employment effects. The chapter drew out the economic impacts of each of these major extensions in the sector, individually and collectively. In the construction phase, it was found that the new mining industries have relatively high output and employment multipliers. The railway network, as well as the smelters and refineries, were possibly the main reason. In contrast, income multipliers were relatively low, due to the leakages caused by foreign workers in this phase. In the operation phase, however, it was found that the new industries have strong linkages both entirely and between each other. On the other hand, the new industries have relatively small linkages with other sectors of the Saudi Arabian economy. This could be mainly due to the imported machines and other import inputs. The high income multipliers reflect the high linkages of these new industries with other sectors in the economy. The new industries have created low employment, reflecting the capital-intensivity of the mining industries.

Chapter Eight was an exploration of the Dutch disease model as proposed by Corden (1984), and an attempt to relate this model to Saudi Arabia, in order to test

whether the case of this country conforms with the predictions of the Dutch disease theory. This theory says that a boom in one sector of the economy does not have only beneficial effects, and may lead to an increase in relative prices of non-tradables, which in turn may lead to de-industrialisation or/and de-agriculturalisation.

Contrary to the Dutch disease symptoms (in the form of a contraction in the tradables sector) observed in the Netherlands and other developed countries, the manufacturing sector actually expanded at the expense of agriculture in most oil-exporting developing countries, including Saudi Arabia, following the oil boom of the 1970s. For the non-oil minerals sector, with which we are especially concerned, the same observation, though with a slower rate of expansion, was obtained. We have seen that there is no unanimous agreement among economists as to why the manufacturing sector expanded in these countries. With regard to the Saudi Arabian case, our empirical study suggests that aspects of Dutch disease syndrome are observed. Using correlation analysis, we have seen that the massive oil export price increase in the boom period led to an increase in relative prices of non-tradables to tradables, an expansion in the non-tradables' share in non-oil GDP, and a contraction in the tradables' share. Within the tradables themselves, it was the agriculture sector which suffered most, unlike manufacturing and non-oil minerals, which actually expanded their shares during the boom period.

However, the equilibrating role of relative price changes in the economy structure does not necessarily operate in the case of Saudi Arabia, due to the fact that price

levels are not an important mechanism for clearing markets. This is because of the dominance of government investment, which was influenced more by the government's development strategy than by relative price and profitability changes. During the post-boom, when the Saudi Arabian oil price witnessed a massive decrease, the Dutch disease syndrome reversed itself in Saudi Arabia, leading to results opposite to those observed during the boom period. The oil decline is expected to cause an expansion in the tradables sector and a relative contraction in the non-tradables sector. However, the adjustment process may take time, due to the higher cost of re-entry into tradables industries. Finally, some policies and recommendations were suggested to the Saudi Arabian government to mitigate the effects of the disease.

9.2 Suggestions for Further Research

The present study can be viewed as preliminary step towards the building of much more detailed and sophisticated model of the contribution of the non-oil minerals sector to the economic growth of Saudi Arabia in future. There are many possibilities of extending the model:

1. The input-output model applied in this study measures only the static effects of a unit increase in the final demand or the impacts of an expansion on the sector. Further extension, would be to try a dynamic model that can capture the dynamic changes associated with capital accumulation and population growth. Given that the future researchers have access to new table and ample data, a dynamic analysis can show fully all of the costs and benefits of these adjustments (changes).

2. Regional input-output can be carried out by the future researchers to estimate the impacts of individual mining projects on the corresponding region's economy. The impacts of a mining project tend to affect a specific areas to a greater or lesser extent rather than to be spread evenly over a country. Thus a minor change at the country level may be a major one for a specific region. As a result, the micro-impacts would complement our macro-impacts by identifying clearly the actual communities affected.

3-Cost-benefit analysis could be applied to weight the actual and potential costs (both private and social) on various proposed mining projects against the actual and potential private and social benefits. This method could help the planners to select between the most desirable (profitable) mining projects in terms of yielding the highest benefits-cost ratio.

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Appendix A: Non-Oil Minerals and Geology of Saudi Arabia

Table A.1: Summary of Known Non-Oil Mineral Resources in Saudi Arabia

Principal deposits	Ore reserve (mt)[1]	Commodity	Annual production	Mine life (year)	Workers
Wadi Sawawin	974.00	Iron	2.2 mt	25	839
Wadi Fatima	12.50	Iron			-
Jabal Idsas	106.00	Iron			-
Al Aflaj	-	Iron			-
Hadbah	-	Iron			-
Wadi Wassat	180.00	Iron			-
Az Zabirah	372.00	Bauxite, Kaolinitic clay, and Aluminium Dioxide	2.5 mt	20	199
Jabal Sayid	60.00	Copper, (zinc)	76,000tonnes Cu (29%)		340
Jabal-Ash Shizm	1.60	Copper, (zinc)			-
Umm-Ad Damar	1.00	Copper, (zinc)			-
Kutam	1.63	Copper, (zinc)			-
Al Masane	7.03	Zinc, (copper, gold, silver)	34,000tonnes Cu (25%), 58,000tonnes Zn (53%)	10	200-
Nuqrah	466.30	Zinc,(copper, gold, silver)			-
Khnaiguiyah	30.4	Zinc, (copper)	638,200 tonnes Zn 11,400 tonnes Cu.	13	176
Sukhaybarat	6.40	Gold			-
Al-Amar	2.20	Gold			-
Al -Amar	6.70	Gold,(silver, copper,zinc)	350,000 tonnes (7,200 tonnes Cu; 16,800tonnes Zn, 720 kg Au; 1320 kg Ag)	10	214
Mahd Ad Dhahab	1.14	Gold,(silver, copper,zinc)			-
Al-Hajar	176.64	Gold, silver	400,000-500,000 t (1.7 grams/tonnes Au)	10	127
Hamdah	4.28	Gold	300,000 tonnes (2.89 gram/tonnes)	8	30
Bulghah	61.68	Gold	3 mt (1700 gram gold bar)	10	159

Summary of Known Non-Oil Mineral Resources in Saudi Arabia (continued)

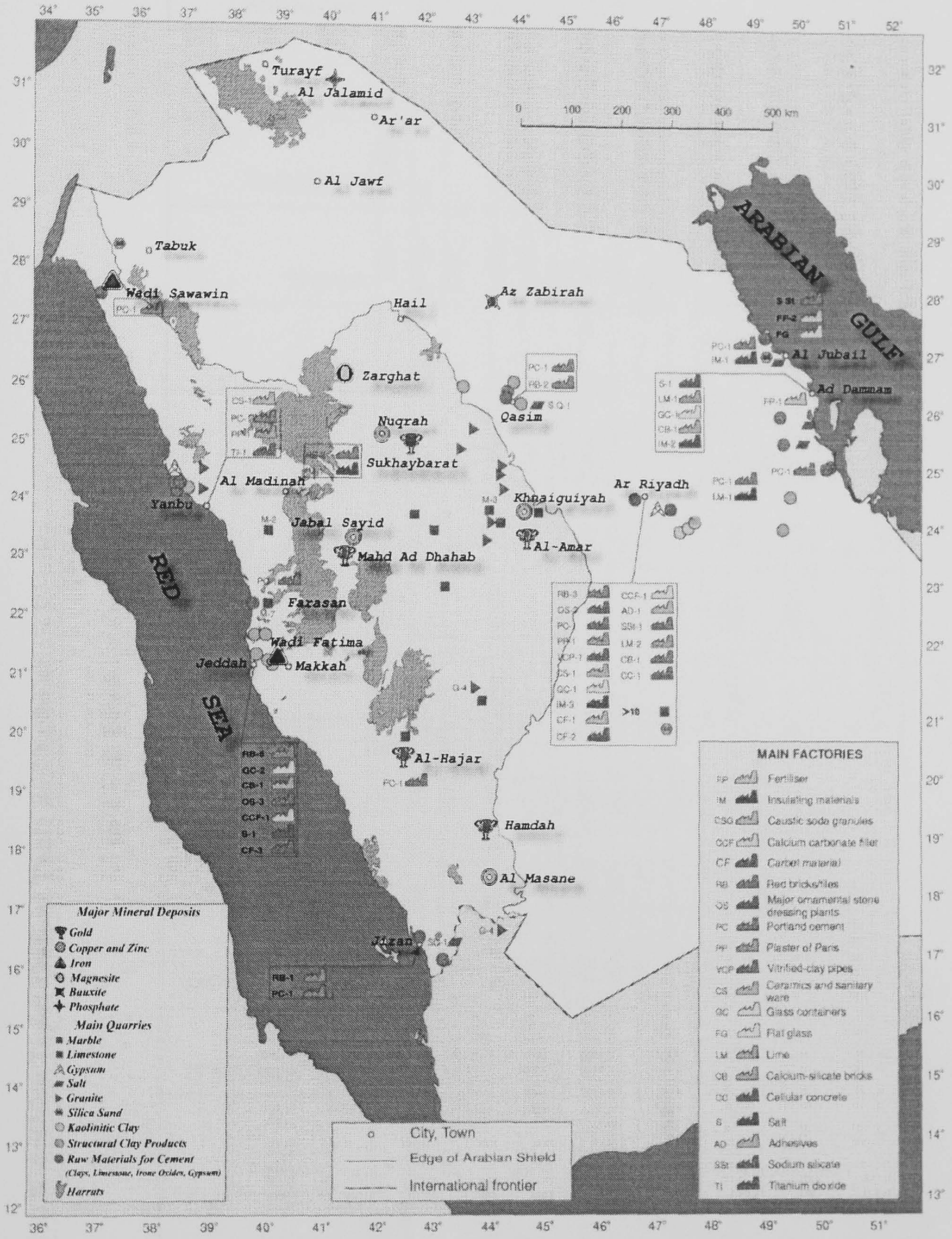
Principal deposits	Ore reserve (mt)[1]	Commodity	Annual production	Mine life (year)	Workers
Dowaihi	0.01	Gold			-
Bil'iwy	0.54	Gold			-
Umm Matirah	1.03	Gold			-
Ash Shakhtaliya		Gold			-
Al Jalamid	1413		11mt (4.5mt phosphatus condensed by 32% of pento phosphates oxides	40	800
Yanbu	16.00	Gypsum			-
Al Butayn	660.00	Silica			-
Yanbu	30.00	Clay			-
Zarghat	3.20	Magnesite	65,000 tonnes	24	24
Al Shahba	2.00	Carbonated rocks	Unavailable		-
Farasan	5.00	Carbonated rocks	Unavailable		-
Raniah	12.00	Carbonated rocks	Unavailable		-
Um Wu'al	250.00	Phosphate			
Tabuk region		Granite	Unavailable		-
Hail Region		Granite	Unavailable		-

[1] Million tonnes.

[2] Diammonium Phosphate.

Source: DMMR (1996) and (1998a).

Figure A.2: Saudi Arabian Non-Oil Minerals Deposits and Main Related Industries



Source: SGS.

Appendix B: Saudi Arabian Input-Output Table and Estimation Results

Table B.1: Saudi Arabian 1994 Input-Output

SECTOR	AGRICULTURE	OIL	NON-OIL MINERAL	MANUFACTURING	ELECTRICITY	CONSTRUCTUON	COMMERCE	TRANSPORTATION	FINANCE	SERVICE	LABOUR	CAPITAL	HOUSEHOLD	GOVERNMENT	INSTITUTION	REST OF WORLD	TOTAL
AGRICULTURE	1272.6	0	0	245.3	0	0	780.8	18.0	0	7282.2	0	1327.2	10493.8	1517.8	14.6	130.7	23083.1
OIL	0	1758.5	143.6	13339.7	0	3848.9	2.5	0	0	2.5	0	8556.4	0	0	87.0	111995.6	139734.7
NON-OIL MINERAL	0	143.6	995.3	5953.0	0	259.0	0.2	0	0	0.2	0	575.8	0	0	5.9	5059.2	12992.1
MANUFACTURING	665.9	447.5	22.5	894.7	1510.4	30643.8	1204.0	3340.5	214.2	28497.6	0	10704.7	51298.6	45180.1	24571.3	756.5	199952.3
ELECTRICITY	13.1	83.5	4.5	22.1	18.7	171.9	138.2	21.7	17.2	390.2	0	521.7	2072.5	1140.7	0	0	4616.1
CONSTRUCTION	0	1539.6	76.4	145.3	457.6	110.5	316.1	230.3	137.1	2811.4	0	4287.7	1308.9	1342.6	73678.4	0	86441.7
COMMERCE	24.7	20.7	1.0	18.4	50.6	674.1	64.0	64.0	12.7	694.7	0	482.7	23899.4	10037.0	303.0	857.2	37204.3
TRANSPORTATION	5.2	489.5	24.7	147.9	69.3	538.9	1311.1	805.2	102.2	2475.8	0	4976.4	8529.2	4623.2	1560.2	7433.8	33092.7
FINANCE	0	42.4	1.8	65.9	1.1	527.3	674.1	116.5	759.9	1186.0	0	885.7	5460.2	3959.2	253.2	683.5	14616.7
SERVICE	0	336.0	16.8	64.0	27.0	2695.7	2978.8	691.3	414.9	2433.5	0	11236.5	24994.8	23980.4	0	3812.8	73682.5
LABOUR	957.2	1091.2	54.4	4438.9	249.4	10331.3	3085.5	3133.4	1932.0	17130.0	0	0	0	0	0	0	42403.5
CAPITAL	6357.9	133754.2	6594.5	66577.1	190.2	36238.5	26649.0	1576.6	11003.5	10653.8	0	0	0	48997.3	0	0	348592.8
HOUSEHOLD	0	0	0	0	0	0	0	0	0	0	42403.5	290092.9	0	0	0	0	332496.5
GOVERNMENT	0	28.0	1.3	0	2041.8	401.8	0	23095.0	22.8	124.7	0	0	4496.2	0	74746.8	63660.5	168619
INSITITUTION	0	0	0	0	0	0	0	0		0	0	0	171200	4019.5	0	0	175220.3
REST OF WORLD	13786.4	0	5055.4	108039.9	0	0	0	0	0	0	0	14945.2	28741.7	23821.2	0	0	194389.9
TOTAL	23083.0	139734.7	12992.1	199952.3	4616.1	86441.7	37204.3	33092.6	14616.7	73682.5	42403.5	348592.8	332496	168619	175220.3	194389.9	1887138

Source: Ministry of Planning (1994).

Table B.2: Input-Output Inverse Matrix (Closed)

SECTORS	AGR	OIL	NON-OIL	MANUF	ELEC	CONS	COM	TRANS	FIN	SERV
AGRICULTURE	1.058	0.000336	0.000197	0.001378	0.001906	0.004208	0.031	0.003179	0.003393	0.109
OIL	0.002115	1.014	0.013	0.068	0.03	0.071	0.005867	0.008287	0.002787	0.031
NON-OIL MINERAL	0.001004	0.00146	1.083	0.033	0.012	0.015	0.00253	0.00379	0.001118	0.014
MANUFACTURING	0.031	0.009133	0.005356	1.006	0.373	0.373	0.077	0.116	0.033	0.428
ELECTRICITY	0.000614	0.000653	0.000409	0.000173	1.004	0.002321	0.004299	0.000849	0.001459	0.005821
CONSTRUCTION	0.00013	0.011	0.006647	0.001733	0.101	1.004	0.013	0.008365	0.011	0.041
COMMERCE	0.001148	0.000284	0.000167	0.000131	0.012	0.008262	1.003	0.002299	0.00135	0.01
TRANSPORTATION	0.000336	0.003851	0.002276	0.001116	0.017	0.008535	0.04	1.026	0.008841	0.037
FINANCE	3.8E-05	0.000473	0.000246	0.000405	0.001528	0.00738	0.021	0.004338	1.056	0.018
SERVICE	0.000128	0.003019	0.00177	0.000651	0.011	0.034	0.085	0.023	0.032	1.038

Table B.3: Input-Output Inverse Matrix

SECTORS	AGR	OIL	NON-OIL	MANUF	ELEC	CONS	COM	TRANS	FIN	SERV	LABOUR	CAP	HOUS	GOV	INSTIT	EXPORT
AGRICULTURE	0.059	0	0	0.001	0	0	0.023	0.001	0	0.106	0	354.4	2505	312.2	3.9	0.001
OIL	0	0.014	0.02	0.058	0	0.037	0	0	0	0	0	1871.6	0	0	19	0.435
NON-OIL MINERAL	0	0.135	0.02	0.018	0	0.011	0	0	0	0	0	566.9	0	0	5.8	0.002
MANIFACTURING	0.031	0.003	0.004	0.005	0.345	0.357	0.035	0.104	0.015	0.414	0	2858.4	12245.8	10345.6	6561.1	0.004
ELECTRICITY	0.001	0.001	0.001	0.000	0.004	0.002	0.004	0.001	0.001	0.006	0	139.3	494.4	304.6	0	0
CONSTRUCTION	0	0.01	0.014	0.001	0.105	0.001	0.009	0.007	0.01	0.041	0	1144.9	312.5	325.9	19673.8	0
COMMERCE	0.001	0	0	0	0.012	0.008	0.002	0.002	0.001	0.01	0	128.9	5705.2	2680	80.9	0.005
TRANSPORTATION	0	0.003	0.004	0.001	0.016	0.006	0.038	0.025	0.007	0.036	0	1328.8	2036	1234.6	416.6	0.044
FINANCE	0	0	0	0	0	0.006	0.019	0.004	0.054	0.017	0	236.5	1303.5	1057.2	67.6	0.004
SERVICE	0	0.002	0.003	0	0.006	0.031	0.086	0.022	0.03	0.035	0	3000.4	5966.7	5821.2	0	0.022
LABOUR	255.6	176.9	53.6	1185.3	66.6	2758.7	823.9	836.7	515.9	4574.1	0	0	0	0	0	0
CAPITAL	1697.7	21437	3492.8	17777.6	50.4	9498.8	6437.9	421	2779.4	1532.2	0	0	0	15197.8	0	0
HOUSEHOLD	0	0	0	0	0	0	0	0	0	0	11247.3	68124.8	0	0	0	0
GOVERNMENT	0	4.1	1.2	0	482.1	107.3	0	5892.7	6.1	33.3	0	0	1073.5	0	15112.9	22000
INSTITUTION	0	0	0	0	0	0	0	0	0	0	0	0	40868.3	1073.3	0	0
IMPORTS	0.57	0	0.277	0.538	0	0	0	0	0	0	0	567.7	6861.1	6360.8	0	0

Appendix C: Impacts of New Mining Industries

Table C.1: Input-Output Coefficients for New Mining Industries Included in Impact Analysis (Construction Phase)

SECTORS	AGR	OIL	NON-OIL	ALU	PHOS	IRON	MANUF	ELEC	CONS	COM	TRAN	FIN	SER	HOUS
AGRICULTURAL	0.055	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.021	0.001	0.000	0.099	0.000
OIL	0.000	0.013	0.011	0.000	0.000	0.000	0.067	0.000	0.045	0.000	0.000	0.000	0.000	0.000
NON-OIL MINERAL	0.000	0.001	0.077	0.019	0.000	0.000	0.030	0.000	0.003	0.000	0.000	0.000	0.000	0.000
ALUMINIUM	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
PHOSPHATE	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
IRON	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
MANUFACTURING	0.029	0.003	0.002	0.077	0.047	0.023	0.004	0.327	0.355	0.032	0.101	0.015	0.387	0.000
ELECTRICITY	0.001	0.001	0.000	0.038	0.047	0.023	0.000	0.004	0.002	0.004	0.001	0.001	0.005	0.000
CONSTRUCTION	0.000	0.011	0.006	0.192	0.391	0.047	0.001	0.099	0.001	0.008	0.007	0.009	0.038	0.000
COMMERCE	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.011	0.008	0.002	0.002	0.001	0.009	0.000
TRANSPORTATION	0.000	0.004	0.002	0.058	0.031	0.023	0.001	0.015	0.006	0.035	0.024	0.007	0.034	0.000
FINANCE	0.000	0.000	0.000	0.000	0.063	0.023	0.000	0.000	0.006	0.018	0.004	0.052	0.016	0.000
SERVICE	0.000	0.002	0.001	0.096	0.063	0.035	0.000	0.006	0.031	0.080	0.021	0.028	0.033	0.000
HOUSEHOLDS	0.041	0.008	0.004	0.385	0.313	0.279	0.022	0.054	0.120	0.083	0.095	0.132	0.232	0.000
EMPLOYMENT	28.7	0.47	0.4	18.1	17.2	17.4	2.692	31.9	6.72	13.3	9.39	8.91	17.8	

Table C.2: Input-Output Coefficients for New Mining Industries Included in Impact Analysis (Operation Phase)

SECTORS	AGR	OIL	NON-OIL	ALU	PHOS	IRON	MANUF	ELEC	CONS	COM	TRAN	FIN	SER	HOUS
AGRICULTURAL	0.055	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.021	0.001	0.000	0.099	0.000
OIL	0.000	0.013	0.011	0.002	0.003	0.003	0.067	0.000	0.045	0.000	0.000	0.000	0.000	0.000
NON-OIL MINERAL	0.000	0.001	0.077	0.003	0.039	0.068	0.030	0.000	0.003	0.000	0.000	0.000	0.000	0.000
ALUMINIUM	0.000	0.000	0.000	0.396	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
PHOSPHATE	0.000	0.000	0.000	0.000	0.274	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
IRON	0.000	0.000	0.000	0.000	0.000	0.183	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
MANUFACTURING	0.029	0.003	0.002	0.050	0.123	0.046	0.004	0.327	0.355	0.032	0.101	0.015	0.387	0.000
ELECTRICITY	0.001	0.001	0.000	0.001	0.004	0.080	0.000	0.004	0.002	0.004	0.001	0.001	0.005	0.000
CONSTRUCTION	0.000	0.011	0.006	0.002	0.009	0.002	0.001	0.099	0.001	0.008	0.007	0.009	0.038	0.000
COMMERCE	0.001	0.000	0.000	0.003	0.024	0.057	0.000	0.011	0.008	0.002	0.002	0.001	0.009	0.000
TRANSPORTATION	0.000	0.004	0.002	0.075	0.030	0.080	0.001	0.015	0.006	0.035	0.024	0.007	0.034	0.000
FINANCE	0.000	0.000	0.000	0.002	0.019	0.039	0.000	0.000	0.006	0.018	0.004	0.052	0.016	0.000
SERVICE	0.000	0.002	0.001	0.004	0.027	0.007	0.000	0.006	0.031	0.080	0.021	0.028	0.033	0.000
HOUSEHOLD	0.041	0.008	0.004	0.395	0.342	0.422	0.022	0.054	0.120	0.083	0.095	0.132	0.232	0.000
EMPLOYMENT	28.7	0.47	0.4	1.3	1.37	1.39	2.692	31.9	6.72	13.3	9.39	8.91	17.8	