A DIVERSIFICATION POLICY MODEL FOR THE SAUDI ARABIAN ECONOMY (CGE MODEL)

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CHAPTER I

INTRODUCTION

Several economic studies have indicated that the short term level of economic activity, output, and employment in mineral exporting countries is vulnerable to price fluctuations in world commodity markets. In order to have both output and income stability in these countries, it is important that the policy makers invoke alternative planning adjustment strategies to accommodate for both desirable and undesirable movements in the foreign terms of trade.

An example of this point would be in the case of Saudi Arabia, which traditionally has relied heavily on oil for its foreign exchange earnings. During the period from 1970 to 1981, oil exports averaged around 90 percent of the total export earnings for the country.

The Problem :

Dependence upon one depleting resource, i.e. oil made the economy face a series of external shocks in the last six years when the price of oil fell below eight dollars as the world demand for oil decreased. This led the country to experience a severe shortage of foreign exchange on which the economic infrastructural development and production depend. As a result, the growth rate of the economy slowed down. Since then, the central concern among the Saudi

Arabian planners and policy makers has been. "What will happen when the oil runs out or the world no longer needs it?"

Therefore, recent development plans have focused on economic diversification as a strategy to increase the production of non-oil sectors such as manufacturing, agriculture, and services in order to reduce dependency on oil exports as a major source of income and foreign exchange earnings. Accordingly, the government provided some incentives such as free loans, export subsidies, and tax exemptions, in order to invest in non-oil sectors such as manufacturing, agriculture and service sectors. In its new plan of (1990-1995), the government increases the tariff rate on imported goods from 3 percent up to 20 percent to protect the domestic industrial and agricultural sectors and to reduce dependency on imports.

Recently, the private firms in Saudi Arabia have argued that the domestic currency (Riyal) is over valued and they demanded it to be devalued.

Thus, in this thesis we will study the general equilibrium effects associated with trade policies such as import tariffs, exchange rate devaluation, and subsidies on domestic production, income, imports, exports, trade balance, and gross domestic product (GDP). Furthermore, we would like to analyze the effect of the decline in Saudi oil exports on the major economic variables in general and non-oil sector exports, imports, and production in particular.

Outline of thesis

The remainder of this thesis is divided into five chapters. Chapter II is an attempt to find a theoretical definition for diversification and review some of the policies that were used in LDCs in this regard. Chapter III discusses some of the structural features of the Saudi economy. Theoretical development of the computable general equilibrium of Saudi Arabia is presented in Chapter IV. Results and simulation experiments are presented in Chapter V. Finally, the summary and conclusions of the study are presented in Chapter VI.

CHAPTER II

DIVERSIFICATION: THEORETICAL AND EMPIRICAL REVIEW

Theoretical Review

In the economics literature, the term diversification has been widely discussed under different subjects. These include the theories of comparative advantage, infant industry, unbalanced growth, duality, liquidity preference and exhaustible resources. Although there is no unique definition for this term, it is generally used to mean an alternative source of income or a reduction of dependency on exporting primary goods.

Diversification and Trade Theory

According to the Heckscher-Ohlin theory a country can promote higher economic growth if it specializes in producing that good which uses the country's abundant factor of production. Some economists, such as Krueger (1984), have rejected this theory because it is based on the assumption of a perfect international market. In reality the international market is distorted.

Krueger and her supporters also argue that history shows that not all Less Developed Countries (LDCs) follow

this theory (such as Korea, Mexico, Malaysia). If they did, they would have specialized in producing primary goods while Developed Countries (DCs) would have specialized in manufacturing goods. Where specialization in producing primary goods might not be beneficial for LDC's because of the declining terms of trade for these goods, price instability, and low Engle elasticities.

Because of these problems, some argue that LDC's should diversify their production structure through an import substitution strategy. Gottfired Haberler (1974) defined diversification to be synonymous with import substitution. Specifically, he defined diversification as the production of secondary (manufacturing) products by import substitution.

Diversification and Investment Theory

Most investment and portfolio theories take into consideration the familiar adage "Don't put all your eggs in one basket." According to Tobin (1958) in his theory of liquidity preference--putting a fixed total of wealth equally into independently identically distributed investments will leave the main gain unchanged and will minimize the variance. Thus, the term diversification, in this theory, means that in order to minimize risk, an investor needs to invest in different assets, so the loss in one asset may be offset by the gain in another.

Diversification and Regional Theory

Brewer, H. (1985), and others who studied the relationship between specialized regional economic structure and economic instability found a positive relationship between the two. They argued that the greater the diversity, the more stable the regional economy, where regional diversity will work as a buffer against instability.

Diversification and Hirschman's Unbalanced Growth Theory

According to this theory, LDCs can diversify their production through vertical or horizontal integration, where such a policy will increase the domestic value added. For example, instead of exporting corn in seed form, it can be processed and exported as oil, thus increasing its value.

Diversification and Lewis Duality Theory

According to this theory LDCs can diversify their economy by developing the industrial sectors. This helps to create greater employment opportunities, increase labor productivity, and improve income equality. Also industrialization will also strengthen the backward and forward linkages in the economy. Thus, according to this theory, diversification means industrialization.

Diversification and The Exhaustible Resource Theory

The Exhaustible Resource Theory argues that the export earnings of mineral exporting countries are often marked by instability because their mineral wealth or reserves are exhaustible. Therefore, they need to adopt a strategy which, through an efficient sequencing and sectoral distribution of investment, will create a diversified and growing economy before their mineral resources are depleted. According to these theories, increased saving and technological progress are important to increasing the growth of an economy with depleting resources (Stiglitz, 1974).

Accordingly, many mineral exporting countries have advocated strategy, such as import substitution, which focuses on domestic processing of natural resources pursuing what is called a Resource-Based Industrialization Strategy (Vielvoye, 1988). Thus diversification can be defined as the reduction of dependency on exporting raw minerals or crude oil.

Diversification as defined by Saudi policy makers

Diversification in the Saudi economy mean reducing the dependency on exporting crude oil, as a major source of income and foreign exchange earning. Moreover, it means reducing dependency on imports, achieving self-sufficiency

on main food products, and finally reducing dependency on foreign labor.

The Fourth Development Plan (1985) defined diversification as transforming the economy from a state of comprehensive dependence on oil to one of diversified industrial and agricultural production.

In the upcoming Fifth Development Plan (1990-95) the government aims to diversify the economy by stimulating and expanding the manufacturing sector which includes both the agricultural and manufacturing industries. Therefore, the government intends to encourage import substitution by providing subsidies and trade protection for selected industries.

In summary, we can say that the term diversification can be defined as a long term structural change in the non-oil domestic production base in order to reduce dependency on crude oil, imported goods, increased alternative employment opportunities, and income stability.

Empirical Studies

Many primary exporting LDC's have tried to diversify their economy by following different strategies such as import substitution (inward looking), export promotion (outward looking) and resource-based processing strategy.

An import substitution strategy was applied by many LDC's in the early 60's and 70's especially by Latin American countries such as Brazil, Colombia and Mexico. These countries tried to reduce dependency on the

exportation of primary goods by developing the domestic industry behind tariff walls.

Empirical studies that used partial equilibrium models to evaluate the impact of such policies found that, in a small country, protection results in static welfare losses. Because tariffs distort domestic prices, there is a consumer loss. Also there is a producer loss which results from the distorted input prices. Thus, tariffs tend to reduce both real output below the maximum attainable and reduce consumer utility below the potential maximum.

Some economists (e.g., Dervis & De Melo, 1977) argue that most of the studies used partial static models which did not take into account the interdependence of economic activity in the sense that the output of one process may be the input of another process and vice versa. He adds that these partial studies omitted a number of important issues by considering only final goods. Furthermore, there is no consideration given to the effects on production costs resulting from shifts in demand for inputs as the economy switches production from one commodity to another. Finally, these partial equilibrium studies ignore the effects on the exchange rate of changes in the tariff structure.

Because of the limitation of the static partial equilibrium model, De Melo (1978) studied the effect of protection on the Colombian economy using a Computable General Equilibrium (CGE) model which took into account the fact that market mechanisms, including special institutional features and distortions, affect the economy of Colombia.

This model traces the effect of protection on trade flows, production, employment, pressure on balance of payments and welfare. De Melo quantified the effects on some key macro variables of tariff allocation within the general equilibrium framework under different assumptions regarding behavior in labor market and foreign exchange policy. He found that welfare gains from labor income increased under the assumption of factor mobility where welfare is an increasing function of the supply elasticity of unskilled labor. The exchange rate will adjust in order to keep the balance of payments in equilibrium. The adjustment is greater under the assumption of factor immobility. Furthermore, he found that trade protection may result in an increase in the saving rate through a change in income and this will increase capital accumulation. Also, if saving depends on total profit, protection increases profit and thus saving will increase and capital accumulation in both manufacturing and nontraded sectors will increase.

Finally, De Melo shows that protection has a positive effect on employment, especially when the supply of labor is flexible, and this explains why welfare is higher under the assumption of factor mobility.

In another study, De Melo (1977) concluded that the static partial equilibrium studies did not take into account the dynamic benefits associated with protection. He built a dynamic CGE model to measure the effect of protection on Colombia and found that within seventeen years of protection, welfare with trade distortion will exceed

welfare under free trade, and investment will reach its peak within ten years.

Export promotion, an outward looking strategy, was another approach to diversification that many LDC's applied in the early 70's especially in South Asian countries such as Korea, Taiwan, Singapore, Hong Kong and to a lesser extent Malaysia. Such a policy often requires the devaluation of the domestic currency to make domestic products more competitive in world markets. Also it may be necessary to subsidize some exports to encourage investment.

In the late 70's some economists such as Krugman and Taylor (1978), and Diaz-Alejandro (1979) argued that devaluation may have a contradictionary effect on the economy due to changes in relative prices that decrease real income and contract aggregate demand for domestic goods.

Empirical studies which analyzed the effects of devaluation are inconclusive. Askari and Bizien (1973) analyzed the effects of devaluation on LDC's in the periods 1957-1967 on exports and imports; they found that exports are more responsive to devaluation than imports. In another study, Donovan (1981) analyzed the effect of devaluation on LDC's during the period 1970-1976 and concluded that in the long run, devaluation is an effective policy.

Applegate, M. (1988) used static analysis to evaluate the effect of devaluation on the economy of Zambia. This study used a non-linear multisectorial model and found that devaluation is expansionary and that the degree of trade substitution plays a major role in determining the magnitude

and direction of the impact of devaluation.

Nwidoko (1988) evaluated the effect of trade policies (inward and outward looking strategies) on the economy of Nigeria and its effect on employment and income distribution. This study used a CGE model in its analysis and showed that protection can increase the level of income and employment. Comparing the above policies with free trade, he found that import substitution policies are much better than free trade in terms of manufacturing output and employment. This shows that trade distortion has a positive impact on some key macroeconomic variables like employment, GDP and consumer income.

In another study, Milner (1989) argued that most of the studies which were done to measure the effect of protection concluded that protection will transfer resources from labor intensive export sectors to capital intensive import sectors. He questioned whether this kind of relation can exist in capital rich LDC's such as Saudi Arabia and Kuwait. Thus, his study focused on the effect of both import substitution and export promotion policies on capital poor and capital rich LDC's. His results for capital poor countries confirmed the results of the previous studies, i.e., import protection hurts the export sectors which bear the principle burden of import substitution. However, in the case of capital rich LDC's the result is different. Where the labor intensive non-tradable sectors bear the principle burden of protection, the protection promotes exports, which are capital intensive.

Finally, Tawi, S. (1989) analyzed the effect of devaluation on the Saudi Arabian economy and found that devaluation has a positive impact on some key macro economic variables such as domestic production of oil and non-oil sectors and government income. He also found that devaluation will improve the trade balance through increasing exports and decreasing imports.

The above studies show that both inward and outward looking strategies can be effective policies in diversifying the economy, and that they each have positive effects on employment, GDP, exports, and imports.

In Chapter II, we analyze in detail the structural features of the Saudi economy and the economic instability associated with exporting oil and the diversification policy of previous plans which aimed at increasing production of the non-oil sectors.

CHAPTER III

THE STRUCTURAL FEATURES OF SAUDI ARABIAN ECONOMY

One of the characteristics of many less developed countries including Saudi Arabia is their heavy dependence on primary exports, where primary goods represents the major source of income and foreign exchange earnings.

This high degree of dependency on a single commodity is thought to be more dangerous in the case of crude oil than any other primary good because the market has been characterized by a high degree of instability in the past ten years. This instability in the world market was very costly to the oil producing countries, especially Saudi Arabia whose oil revenues slid from $113 billion in 1981 to less than $18 billion in 1986.

To have a better understanding of the features of the Saudi economy structure, we focus our analysis 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 the agricultural sectors.

Role of the oil sector in the Saudi economy

Oil plays a crucial role in the Saudi economy, where it

is considered the most valuable resource in the country in terms of providing the government with most of its income and highly needed foreign exchange. During the period of (1973-1981), the oil sector generated about 80 percent of gross domestic product (GDP), about 90 percent of government revenue, and 95 percent of total exports. Thus if it had not been for oil, Saudi Arabia would have been considered one of the poorest countries in the world.

Before oil was discovered, Saudi Arabia was a poor country with a low per capita income where most of its income came from the agricultural sectors. The country was considered a "backward" country even by the standards of less developed countries in terms of literacy, life expectency, and the infant mortality rate. Table (1) shows that in 1950 the Saudi literacy rate was only 3 percent and life expectency at birth was 30 years. This picture started to change when oil was discovered in the late thirties. Oil income helped the country to improve its social welfare. Through investing in education and health care. Table (1) shows that the literacy rate increased from 3 percent in 1950 to 52 percent in 1983 and in terms of health, the population per physician changed from 18,000 in 1950 to 1,690 in 1977. Life expectency at birth has from 30 years in 1950 to increased 56 years in 1983. But because the country did not have adequate infrastructure facilities nor sufficient investment capital that is necessary for a modern developed economy, the country could not have satisfactory development of the industrial and agriculture sectors.

TABLE I

ECONOMIC AND SOCIAL INDICATORS FOR SELECTED YEARS

	1950	1960	1977	1980	1983
GNP Capital	**	**	6,040	11,260	12,230
Literacy Rate (%)	3	3	16	25	52
Population per Physicaian	18,000	13,000	1,690	**	**
Life Expectancy at Birth in Yrs.	30	38	48	54	56
Child Death Rate/1,000	50	48	28	18	13
Infant Mortality Rate/1,000	**	164	**	114	101

Source: World Bank, World Developement Report various issues.

Therefore the country has increased its dependency on oil as a major source of income.

In addition, the oil embargo that took place in the early seventies and its impact on the oil world market resulted in high oil prices and income but also increased the dependency of Saudi economy on oil export revenues. The share of crude oil in GDP increased from 63 percent during the sixties to 84 percent in 1973, and 90 percent in 1981 with an income of $113 billion compared to $1.02 billion in the late sixties. This can be seen clearly from Table II. Also during the period of 1973-1981 oil revenues represented 90 percent of total government revenues and 93 percent of total export earnings.

This massive oil income inflow enabled the country to execute and embark on long term economic development planning to reduce dependence of the economy on oil exports and to diversify the economy. Therefore, the major objective of all the development plans (1970-1980) was the creation of a modern and diversified economic base capable of sustaining future economic growth. The avenue of diversification was full of obstacles such as lack of adequate infrastructure (such as roads, ports and communication facilities), lack of productive skilled and unskilled labor, and technical know-how. Therefore the period of 1970-1980 was of one huge government expenditures that amounted to approximately $600 billion spent on infrastructure development. Although the development plans were successful in removing most of the economic obstacles,

TABLE II

TOTAL REVENUES, FOREIGN RECEIPTS, GDP, AND THE SHARE OF OIL IN EACH OF THE YEARS 69/70-80/81
(MILLION DOLLARS)

	1969/70	1970/71	1971/72	1972/73	1973/74	1974/75	1975/76	1976/77	1977/78	1978/79	1979/80	1980/81	Average Share
Total revenues		1,764	2,688	3,703	12,630	28,198	28,662	38,498	40,455	39,562	44.42	51.30	
Share of oil		90	87	88	88	94	94	90	85	.90	83	91	90
Total foreign exchange receipts		2,438	3,180	4,373		35,270	30,637	40,171	46,713	44,183	52 40	64 30	
Share of Oil		90	93	93	92	95	91	90	85	.90	83	91	92
GDP		5,018	6,729	9,660	27,842	37,700	44,540	56,667	63,449	60.46	66.02	98 30	
Share of oil													
Rate of Growth		31 6	23 4	43 9	46 6	35 4	17.5	27 2	11 0				29 6
Share of oil		.63	67	72	84	83	74	.68	60				74

Source SAMA, Annual Reports, different issues

it didn't succeed in diversifying the source of national income or in reducing dependence on oil. The economy continued to rely on oil exports as the major source of income and foreign exchange.

This high dependence on oil lead the Saudi economy to face a series of external shocks during the past seven years when the price of oil fell below eight dollars per barrel. This caused the country to experience a severe reduction of foreign exchange on which infrastructural development and production depended. As a result, the growth rate of the economy slowed. The decline in oil prices, resulting in part by a decline in oil demand, resulted in considerable cuts in government budgets. Government expenditures were down to SR 244 billion in 1983, SR 230 billion in 1984, 215 billion in 1985, and less than SR 200 billion in 1986. This can be seen clearly in Table III. Table IV shows that in 1986 income was $18 billion compared to $101 billion in 1981.

All this shows the vulnerability of Saudi economy to changes of in income. Since 1981, the Saudi policy makers changed their development strategy by focusing on investment in non-oil sectors such as manufacturing and agricultural. Therefore, the third and fourth development plans which covered the period of (1980-1985) and (1985-1990) established a new policy which accelerated the diversification process of the Saudi economic structure and reduced dependency on oil as a major source of income.

TABLE III

BUDGET ALLOCATIONS BY SECTOR (1401/1402-1408/1409)
(IN THOUSANDS SR)

	1401/1402	1402/1403	1403/1404	1404/1405	1405/1406	1407/1408	1408/1409
Human resource development	26,248	31,864	27,791	30,406	23,962	23,725	23,388
Transport and communications	35,343	38,533	24,950	23,630	16,500	11,934	9,493
Economic resource development	22,679	22,045	13,209	17,560	14,434	8,439	5,888
Health and social development	13,716	17,010	13,591	18,080	14,830	11,094	10,806
Infrastructure development	14,126	11,705	9,583	9,830	6,670	4,300	3,555
Municipal services	26,292	26,224	19,070	17,460	11,800	8,100	7,017
Public administration & government utilities etc.	43,113	48,436	47,053	35,055	31,582	31,266	25,058
Lending to credit institutions	24,850	19,532	20,000	17,500	9,300	3,590	590
Local subsidies	9,100	11,162	9,020	10,525	8,343	6,800	5,325
Non-defence expenditure	212,467	233,511	184,267	180,100	137,511	109,248	91,120
Defence and security	85,533	89,889	75,733	79,900	64,085	60,752	50,080
Total Planned expenditure	298,000	313,400	260,000	260,000	201,596	170,000	141,200
Actual expenditure	28,000	244,000	230,000	215,000	191,000	------	-----

Source: Various SAMA and goverment publications.

TABLE IV

CRUDE OIL PRODUCTION AND OIL REVENUE

Year	Total Production (million barrels)	Average Daily Production (million barrels)	Total Revenue (million of US dollars)
1968	1,113.7	3.04	926.4
1969	1,173.9	3.21	949.2
1970	1,386.7	3.79	1,214.0
1971	1,740.6	4.76	1,884.9
1972	2,202.0	6.01	2,744.6
1973	2,772.6	7.59	4,340.1
1974	3,095.1	8.47	22,573.5
1975	2,582.5	7.07	25,573.5
1976	3,139.3	8.57	30,754.9
1977	3,358.0	9.20	36,540.1
1978	3,038.0	8.32	32,233.8
1979	3,479.2	9.53	48,435.2
1980	3,623.8	9.90	84,466.4
1981	3,579.9	9.81	101,813.0
1982	2,366.4	6.48	70,478.6
1983	1,656.9	4.54	37,351.6
1984	1,492.9	4.08	31,470.3
1985	1,158.8	3.17	18,322.9
1986	1,746.2	4.78	13,554.8

Source: SAMA Annual Report, different issues.

Oil pricing policy

Until 1985 Saudi Arabia played the role of "sawing producer". During the period of excess supply, where all other members of OPEC produced at their full capacity, Saudi Arabia tried to balance the market by adjusting its production to ensure the target price during that time.

This strategy enabled OPEC countries to increase oil prices during the 70's when the price of oil rose as high as $34 per barrel during 1980-1981. However, this continuing increase in oil prices forced the oil importing countries to cut their demand for oil through conservation and energy switching.

Besides this, the emergence of new oil producing countries such as England and Belgium put pressure on OPEC which realized that its role in determining oil price is not as dominant as it used to be. As a result, in March of 1985, the OPEC members agreed to cut their crude price to $28, and at the same time, they set a ceiling or quota for their production level (see Table V).

Pressure from non-OPEC producers and quota violations by some OPEC members forced OPEC to abandon its $28 per barrel price. Despite this, the oil price continued to decline because of differences in national priorities among OPEC members. Therefore, the price of oil plummeted to around $10 per barrel in the middle of 1986.

Consequently, Saudi Arabia as "sawing producer" bore the burden of the fluctuation in world oil market where its

TABLE V

SAUDI OIL EXPORT PRICES, 1960-85

Year	Oil Export Prices (US $ per barrel)
1960	1,800
1961	1,800
1962	1,800
1963	1,800
1964	1,800
1965	1,800
1966	1,800
1967	1,800
1968	1,800
1969	1,800
1970	1,800
1971	2,285
1972	2,484
1973	5,036
1974	11,651
1975	11,951
1976	12,376
1977	13,660
1978	13,660
1979	24,000
1980	32,000
1981	34,000
1982	29,000
1983	28,23
1984	28.00
1985	21.00

Source: Oil and Energy trends, 1988 Statistics Reviews, Economist Quartly Review of Saudi Arabia

output share in the world market decreased from 21 percent in 1980 to 4 percent in 1982. In volume, Saudi Arabia's output fell from 9.8 million barrels a day in 1981 to about 2.2 million in 1986.

Since then, the Saudi policy makers realized that the world oil industry was in the middle of an oil recession. Therefore they started to re-evaluate their policy with respect to oil production and prices. They established a new strategy which is guided by a long-term consideration aimed at providing stable conditions and a unified price structure in the world market, adequate supplies of oil to meet the requirements of consuming countries, and safeguarding the future of the country's oil reserves.

During an OPEC meeting in 1986, Saudi Arabia announced officially that it would give up its role as a "sawing producer", and instead it would take its right to defend its fair share as a country where has the largest oil reserves in the world.

As a result Saudi oil production increased in 1987 to 4.2 million barrels a day and 5.4 million in 1988. The gulf war conflict in late 1990 and the world trade embargo in Iraq and Kuwait resulted in a 7 percent shortage in the world oil market. Consequently, the Saudi oil industry increased production to fill the gap in the world supply. Saudi Arabia increased its oil production to about 9 million barrels a day, and at the same time the oil prices stabilized to around $20 a barrel. But unfortunately, this ıncrease ın the price and output of oil did not offset the

cost of the Gulf war to Saudi Arabia.

In the future the stability of oil markets is not guaranteed especially when the sanctions on Iraq are removed, and when Kuwaiti oil fields comes into production as expected in 1992. All this will put some pressure on oil prices and Saudi output. But the improvement in the world economy and the sharp slowdown in the growth of non-OPEC supplies will push prices upward. Hence some studies show that a third "oil-price shock" will take place in 1995 (Bunker, Boom, & Gunt).

Oil as a depleting resource

One of the essential advantages of 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, oil producing countries must contend with the fundamental fact that their oil wealth is exhaustible. This fact makes Saudi authorities realize that the base of their economy is very weak as long as it depends on the export of a single depleting commodity. This realization lead the policy makersto 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 run. Therefore, the fourth and fifth development plans emphasize economic diversification and industrialization, which must be done within a reasonable time period otherwise the country might risk entering the next century with

depleted oil resources, financial assets eroded by inflation and much larger population (Noreng, 1978).

Although Saudi Arabia has the largest proven oil reserve in the world which is estimated to be around 300 billion barrels, this resource is not enough to last (at 1990 levels of production) for more than fifty years.

Oil and its Economic Linkages

It is clear from the above argument that continual Saudi dependency on oil is thought to be dangerous for a number of reasons. First, oil is a finite resource and reserves must eventually be exhausted. Secondly, the oil market is characterized by uncertainty and instability because oil demand depends on many variables which are beyond the Saudi government's control such as the performance of world economy, the availability of alternative energy sources, and the oil reserves of the industrial countries. Also there is a third reason for the uncertainty that is associated with the dependency on oil exports: the oil sector has weak linkages to the rest of the economy.

In his study of OPEC countries and their economic problems, Amuzeger (1982) states that "Unlike other industries which draw their inputs of land, labor 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. Petroleum remains a highly insulated and

technologically advanced industry with little direct spillover into other economic sectors."

In another study that analyzed the structure of oil-economics, First (1980) argued that "The oil revenues that accrue to governments in the form of rents make possible spectacular government expenditures and thus certain future rapid economic growth without corresponding change in the society at large", and she added that

> -- revenues occur directly to government, not through any production, but from oil taxes which come from outside the economy.

Oil producing countries realized that oil production has an insignificant direct impact on development of the sectors outside the oil field. 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, by exporting oil, is meant to trade the underground assets for foreign exchange, which is necessary to import desired goods build the country's infrastructural base, and obtain capital goods or machinery which is essential to improve productivity.

For example, if we assume that domestic output in Saudi Arabia is a function of capital, skilled and semi-skilled labor, infrastructure such as schools, roads, ports, etc. then:

output = f (capital, labor, infrastructure)

In the case of Saudi Arabia capital is the abundant factor relative to the other factors of production. Johany (1980) argues that if the country utilizes its revenue from oil in

building the country's infrastructural 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 mid-70's came to believe that the "magic wealth" of oil was capable of overcoming any economic obstacle, such as the poor infrastructural base and lack of skilled and trained labor. They were partially right as the oil wealth enabled the country to increase the number of schools by 15 percent during the period of 1972 and 1982 and university enrollment by more than five fold from 9,000 in 1972 to about 50,000 in 1980.

But on the other hand, the oil sector has weak backward and forward lingkages, where its total employment represents less than 2 percent of the total labor force. This attributable to capital intensive which is main characteristics of oil industry.

Due to market instability, depletability and its weak backward and forward linkages, the Saudi authorities came to realize the limitations of the dependency on oil exports. Therefore, they assigned a crucial role for the diversification of the economic base away from oil by investing in productive non-oil sectors such as the industrial and agricultural sectors.

Role of the Non-Oil Sector

The emergence of the modern non-oil sector began in

1970 when the country established a reform program which allocated a large portion of oil income to the development of Saudi infrastructure, agriculture, industry and social services. In spite of these development efforts, the non-oil sector - until the early 1980's accounted for 25 percent of GDP and 10 percent of total exports for the same period.

In analyzing the role of the non-oil sector, we will focus our analysis on three non-oil sectors: manufacturing, construction and agriculture.

Manufacturing sector

In the eve of oil discovery, Saudi Arabia had no industry except some traditional crafts and cottage. During the 1960's, the growth of the industrial sector continued at a slow rate, but after the oil boom in 1973, the country devoted part of its oil income to building a new modern industry and the growth rate of industrial sectors started to accelerate. As a result, the number of industrial licenses issued by the Ministry of Industry up to 1979 reached 2,100 by 1979 compared to about 300 licenses issued up to the end of 1969, i.e., and increase of 700 percent.

In spite of this positive achievement in the industrial sector, the country still depended on importing most of its manufacturered goods such as motor vehicles, textiles, machinery, and various intermediate goods for manufacturing and construction. Table VI shows the composition of Saudi import by commodity group.

There were many complex obstacles and limitations that

hindered the development of the industrial sector during the last decade such as manpower shortages, lack of technical and managerial know-how, and the lack of entrepreneurs who are capable of utilizing investment capital efficiently, and at the same time, ready to accept some degree of risk.

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. The building materials industry was the first major manufacturing branch where private enterprise played a dominant role. This industry benefitted much from the boom construction activities during the boom years in the 70's. The cement industry for example, expanded rapidly because of escalating demand, domestically available raw materials, and generous finance provided by Industrial Development Fund (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 percent, and accounted for 57 percent of the total manufacturing employment.

Due to the completion of the infrastructure base in Saudi Arabia and the low oil income in the early 1980's, cement industry experienced a low growth rate. Where the early recession of 1980's led to the closing of many of the less efficient manufacturing projects established during the boom of the 1970's. The cost of building and operating industries has been reduced by up to 50 percent, mainly because of reductions in the cost of real estate, rents, labor, and building materials. Accordingly, greater

TABLE VI

COMPOSITION OF IMPORTS

	Commodity Group	1980	1981	1982	1983	1984
1	Live animals and animal products	4,121	4,874	4,980	4,975	4,696
2	Vegetable products	5,345	7,144	8,276	6,588	8,859
3	Animal & vegetable fats, oils & their products	554	407	537	426	550
4	Prepared foodstuffs, beverages spirits vinegar & tobacco	4,172	4,854	4,361	4,597	4,634
5	Mineral products	3,155	3,063	3,043	3,475	2,913
6	Products of the chemical & allied industries	3,475	4,121	4,881	5,081	5,245
7	Artificial resins and plastic materials, cellulose esters, rubber, synthetic rubber	2,795	2,911	3,397	3,501	3,468
8	Raw hides and skins, fur skins and articles thereof, travel goods & hand bags	385	409	471	504	484
9	Wood & articles of wood, charcoal,cork & articles of cork & wicker work	2,795	2,650	2,711	2,799	2,095
10	Paper making materials, paper card board & articles thereof	1,017	1,353	1,536	1,600	1,605
11	Textiles and textile articles	6,571	7,294	8,251	9,056	8,823
12	Footwear, headgear, umbrellas, sunshades, whips, artificial flowers, articles of human hair & fans	530	674	794	920	853
13	Articles of stone plaster, asbestos, ceramic products, glass & glassware	3,421	3,515	3,487	4,160	3,669
14	Pearls precious & semi-precious stones, precious metals, articles & imitation jewellery	2,397	3,478	3,872	4,205	3,605
15	Base metal & articles of base metals	14,611	17,443	20,716	19,101	14,183
16	Machinery, mechanical appliances, electrical equipment & parts thereof	24,534	30,323	35,536	36,120	28,409
17	Transport equiptment	13,924	17,242	24,034	19,087	15,916
18	Optical, photographic, measuring, checking, precision, medical & surgical instrument & apparatus, clocks& watches, musical instruments, sound records & reproducers & parts thereof	3,616	4,313	4,666	5,279	5,014
19	Arms, ammunition and parts thereof	61	29	8	13	23
20	Miscellaneous mnufactured articles	2,772	2,979	3,553	3,613	3,355
21	Work of art collection pieces & antiques	207	222	270	317	337
	Total Imports	100,350	119,298	139,335	135,417	118,736

Source ministry of Finances and national Economy, Central Dept of Statistics (Foreign Trade Statistics YearBook)

efficiency and more competitiveness were established during the late 1980's where the number of manufacturing units established was about 3700 units with an increase of 150 percent compared to the number of units established in the late 1970's. Most of these new manufacturing units concentrated basically on import substitution, hydrocarbon or non-hydrocarbon industries.

As stated above, the weak structure of the non-oil sectors is a consequence of a number of complex factors that include labor strategies, the lack of technical and managerial know-how, the lack of entrepreneurial personnel who are capable of efficiently utilizing the available investment capital and at the same time ready to accept some degree of risk.

Haagen in his book The Economics of Development (1975), states that:

> "Every economist would agree that in any country there is some limit to the rate of capital formation that can be carried out at any given time with a resulting increase in productivity. There are technical and other limitations. Among the technical ones are the size of the construction industry, the availability of materials for capital construction and of workers for construction and subsequent operation, the capacity of the ports and transportation system to carry capital goods, of the communication system to carry messages, of the country's housing to house expatriate or migrant builders and workers, and of the existing productive complex into which or onto which they must depend in part for their productivity. Other limitations would include the number of individuals in the society with adequate managerial and technical capabilities, including in the extreme case the capability of making contracts with foreigners to do the capital formation, and the values and motivations of many groups in the society: of workers, which affect their availability for new enterprises; of

> government officials, which will determine the degree of waste, corruption, and misdirection of investment. . . ."

Saudi Arabia faces most, if not all, of these problems. Therefore the first and third development plans put a heavy emphasis on the development of national infrastructure - of modern highways, ports, schools, electricity sector where by the end of its third plan, the country had already spent more than $600 billion. This does not mean that investment in industry or agriculture did not take place, but rather that infrastructure type of investment has so far been predominant.

Such kind of planning has been criticized because it didn't have any direct links to productive activity. Therefore Kuburasi, A (1984) argued that:

> "The development of infrastructure without tying it directly to productive activity vitiates the economic effort in two fundamental ways. First it raises the average social unit cost of use, second such investment are a drain on future capital budgets as maintenance will eat up over time a large portion of future revenues, leaving less available for other alternatives. Were productive investments made simultaneously, their social surplus might be used to defray such costs. The heavy emphasis on infrastructural development in the region was almost divorced from productive investments and some have even gone as far as to suggest that it had taken place at its expense."

Diversification strategy

The country's strategy of reform and development has been changed during the early 1980's, where the decline in

oil prices during this time accelerated the country's process of diversification. Therefore the fourth and fifth development plans put more emphasis on operational efficiency and the economic use of resources and facilities, along with a goal of developing or discovering renewable alternatives; a greater emphasis on economic diversification, especially in the non-oil production sectors; a commitment to reduce the expatriate work force by more than half a million through a Saudization program; encouragement of a greater role for the private sector and achievement of more effective technology transfer through the promotion of joint ventures.

Given a decision to diversify through industrialization, it then becomes necessary to select those industries most suitable to the endowments of the country and that have a strong backward and forward linkages to the domestic economy. Also due to the Saudi manpower shortage, the diversification program gave a priority to those projects which were characterized by capital intensive labor saving. In its struggle to diversify the economic base away from the oil sector, Saudi Arabia needs to establish new industries that take into account the limitations of the domestic market and are be export oriented. They are required to be competitive industries, that can compete in world markets, Therefore, the new industries should be characterized by economies of scale.

Accordingly, the hydrocarbon based industries, e.g., oil refineries, fertilizers, petrochemicals, steel and

aluminum smelting plants which use the associated gas as industrial feedstock (which was flared during the past), and crude oil which is available at a competitive price. This kind of industry will enable the economy to have a higher rate of return per unit of oil or natural gas that it used. For instance, a barrel of oil which costs $18 can produce a good which worth approximately $90 when turned into a common commodity plastic such as polypropylene, and if it is converted to products such as polyester film or agriculture chemicals, the value is raised fifty to one hundred times (European Chemical News, 7, July, 1978, p.6).

The hydrocarbon base industry, besides its utilization of domestic natural resource, also provides forwards linkages to variety of secondary industries such as plastic, detergents, and paint industries.

In realizing the advantages that the economy could reap from joint ventures with foreign companies in many areas of industrial activity, both in terms of management and technology transfers, the Saudi planners established the Saudi Basic Industries Corporation (SABIC), which is responsible for a wide range of oil and non-oil basic industries. SABIC collaborates with U.S., Japanese and British companies who are requested to provide the latest technologies in their respective fields and to transfer these technologies to Saudi personnel. Apart from providing management, technical skills and capital, the foreign partner has to market most of the products.

In addition to the encouragement of foreign investors,

the government encourages the domestic private investors to invest in those projects which have high value added and result in import substitution. Partly due to government incentives, the private sector has in fact developed rapidly in recent years. From the 1984 to 1990 the number of private sector establishments more than doubled to nearly 200,000.

Despite the decline in government spending during this period, the overall non-oil economy has performed surprisingly well, for five reasons. First, the budget cut came during a time in which the country had just completed its basic infrastructure. Secondly, the availability of domestic goods in the market enabled the government to achieve significant cost saving by purchasing domestically instead of having to import more expensive foreign goods and services. Third, the government called upon the domestic banks to play a much larger role in mobilizing funds for domestic investment. Fourth, the fluctuation in the world financial markets during 1987 and the decline of the dollar lead to a low rate of return on the private investment overseas. Under these conditions many private investors withdrew their foreign investments and invested domestically. Finally, in its latest development plan, the government is prepared to introduce a 10-20 percent advoloreum tariff on competing imports in order to protect "infant" industries from unfair foreign competition, mainly dumping.

Agriculture sector

The basic facts of agriculture in Saudi Arabia are that it employs about one quarter of the Saudi work force. Although it accounted for only 5.4 percent of GDP in 1985, it is the sector with the lowest value added per worker. Environmental and harsh climatatic factors are the reason for thus. Despite this, the agriculture sector in Saudi Arabia observed a major success during the third plan (1980-1985), when the annual rate of growth of production was approximately 8.7 percent, and that was mostly because of the government incentives to farmers in the forms of loans, and subsidies.

In its emphasis on diversification and its endeavor to achieve self-sufficiency and not rely on imports for its needed food, the government aimed at large-scale mechanization of the agricultural sector in order to introduce efficiency to this sector and reduce its cost of production. Such a policy helped the country to have self-sufficiency in wheat, some vegetable products, and milk. For example, the production of wheat in 1976 was less than one percent of the country's demand, but through a heavy subsidy program the country was able to satisfy the domestic demand of wheat and export more than two million tons in 1984. The wheat subsidies program was criticized by many foreign observers who argued that Saudi Arabia's production of wheat was at a very high cost while it could be imported at a much lower price. The minister of agriculture replied

to such critics by saying, "wheat has become, like many other food products, a political commodity, countries sell wheat under certain conditions. Why should we become hostages for these countries? We should not look at this issue from a narrow economic point of view-- that means only through profit maximization."

But starting from 1985 the government reduced the support price for wheat from SR 3.5 per kilogram to SR 2. This reflects the fact that the cost of producing wheat is lower now than ten years ago and also reflects the government's concern for the rapid depletion of the non-renewable water supplies. The country has no rivers, and it has been said that it is easier to find oil in Saudi Arabia than water.

By introducing efficiency to the agricultural sector, this sector was able to achieve a high rate of growth without increasing its employment. The decline in the employment level of this sector forced many laborers to the industrial sector, and this reflects the improvement in the labor productivity in this sector.

In its effort to stimulate agriculture production, the government started to buy some agricultural and domestic goods and donate them to third world countries.

Recently, the private sectors in Saudi Arabia have claimed that the domestic currency (Riyal) is overvalued, and they pressed for a reduction in its value (depreciation) by some 10 percent. On the one hand, such an action might help to improve the domestic product competition in the

world market and boost exports. On the other hand, it might reduce import and encourage import substitution industry.

To sum up, the Saudi Arabian authority attempted to diversify the economy and reduce dependency on oil exports, on import for both industrial and food products, and at the same time utilize the country's natural resources and improve the skills of Saudi labor in order to reduce dependency on foreign labor.

Objective of the Study

In this study, we will analyze the effects of various trade and incentive policies aimed at diversifying the economic structure of Saudi Arabia. The analysis will be carried out through comparative experiments within the framework of a CGE model. Simulation will be performed to assess the impact of outward and inward looking strategies on non-oil sectors, output, exports, imports, and the level of employment.

We will assume that trade policies affect the production decisions of optimizing agents directly at the beginning of the period. Sectoral production levels, hence the sectoral resources used are determined according to relative prices which are assumed to be affected by trade policies. Tariffs and devaluation will change the relative price of tradeable goods with respect to non-tradeable goods, and this will lead resource allocation towards those sectors where there is room for import substitution and/or where exports can be expanded. Thus in the case of a rich

capital country such as Saudi Arabia, we expect that trade policies will promote the export sector which is the capital intensive sector.

CHAPTER IV

METHODOLOGY

Introduction

This study analyzes the effects of various trade and incentive policies aimed at diversifying the economic structure of Saudi Arabia. The analysis is carried out in terms of a computable general equilibrium model (CGE) which is also called an applied general equilibrium model. It is implicitly based on a social accounting matrix (SAM) accounting system.

Although there are different tools that can be used to support policy analysis, such as econometrics and input-output models, CGE is the most suitable one that can provide a detailed framework for examining the effects of trade policies such as tariffs, subsidies and exchange rate devaluation on the economic sectors in terms of imports, exports, and income and employment.

Although the input-output model pioneered by Leontief is the starting point for almost all the analytical frameworks that focus on trade and the structure of production, it has several drawbacks. First, it can't trace the effect on outputs when there is a cost or price change, because of the use of the fixed technological coefficients

of production. Second, the relationships in input-output are assumed to be linear. Thus, by assumption there is no substitution among primary factors of production, consumption goods, and between imported and domestic goods. Finally, in input-output models sectoral outputs are determined only by final demand. Thus, there is no connection between supply and price. Consequently, input-output models are not suitable to investigate a wide variety of policy issues such as trade, fiscal policy analysis and tax reform analysis where such policies are likely to affect relative prices.

Despite the fact that CGE models are basically an extension of the Leontief input-output models, they overcame most of their drawbacks. Relationships in a CGE model are specified as non-linear functions and will allow the endogenous product prices to clear the product markets. The second advantage of CGE models over input-output models is that they incorporate substitution possibilities between primary factor inputs, i.e., labor and capital, and between imports and domestic goods.

Thus, following Dervis (1982), CGE models can be defined as "price-endogenous multisector non-linear models that postulate neo-classical production functions and price responsive demand functions that are linked around an input-output matrix in a Walrasian general equilibrium framework."

In the last decade numerous applications have adopted the CGE approach for a wide variety of policy issues such as trade policy analysis, income distribution, resource

allocation and energy policy. Because foreign exchange is scarce in most developing countries, the issue of foreign trade policy has occupied the centerplace in the majority of applications for developing countries.

In CGE models only relative prices matter. Producers are profit maximizers facing non-increasing returns to scale, consumers are insatiable utility maximizers, and production factors are paid according to their marginal revenue productivity. Thus, the solution to a CGE model is a set of wages and prices such that the labor and product markets clear and the total demand for foreign exchange is consistent with the available supply of foreign exchange. Accordingly, the solution or the outcome represents an economiy-wide equilibrium in product and labor markets and in foreign exchange markets given exogenously specificed market constraints and sectoral availabilities of labor and capital. Hence, the model solution does represent a neoclassical free market equilibrium solution constrained by behavioral and institutional specifications believed to represent a realistic representation of the Saudi economy.

Accordingly, prices in CGE model affect not only the production decisions, but also the income received by producers households and government. Consequently demand for other products in the economy as well as savings and investment are also determined endogenously. Thus, CGE models are unlike other approaches such as input-output or econometric models which don't have flexible prices and feedback loops that are considered important in determining

the total effects of various policies. For instance, in developing countries where the central government has great influence on the development processes, a change in these policies affects relative prices which play a key role in allocating resources and determining sectoral output levels and levels of household. Such countries need to choose an appropriate methodology that eliminate the problems that emerge with partial equilibrium analysis, such as incorporation of factor price effects, substitution between domestic and imported goods, and exchange rate effects. Therefore, the most adequate approach for such countries is a CGE model.

The fact that the CGE model simulates the working of a market system does not imply that markets are "perfect" in the neoclassical sense. Instead, the CGE model explicitly incorporates market rigidities and imperfections, i.e., the existence of unemployment. Therefore, some effort was recently made to include non-neoclassical features in empirical CGE models in order to represent market imperfections and rigidities.

The CGE model can be a dynamic one that can be run forward over a number of years by updating all the exogenous variables entering the static model, such as the change in capital stock, the growth of labor supply, the exchange rate, etc., and finding a new comparative static solution for each year.

The model presented in this study belongs to the class of computable general equlibrium (CGE) model discussed

above. Specifically, it is an application for Saudi Arabia Arabia of one of a family of CGE models introduced by Dervis, de Melo and Robinson (1982). The Saudi Arabia CGE model is a neoclassical model which among other features, recognizes Saudi Arabia partial domination in the world production of oil.

In general, the economy is aggregated into eleven sectors: agriculture, crude oil, mining, petroleum refining, manufacturing, utility, construction, trade, transportation, finance and services. Each sector produces a homogeneous output. The petroleum sector is the pillar of Saudi Arabia export economy earning about 90 percent of the country's foreign exchange in 1987. All the value added in this sector occures to the Saudi Arabian government in the form of oil export taxes. Therefore, we treat government as our agent that collects taxes and transfers them back to consumers and producers in the form of subsidies or services.

Like most recent studies, we assume that domestic and imported goods are imperfect substitutes. This imperfect substitution is measured by an elasticity which is different from one commodity to another. The model assumes that Saudi Arabia is a small country in the world import market. Thus, it is a price taker. This assumption implies that import supply functions are perfectly elastic. On the export side we assume Saudi Arabia is not a small country, especially in terms of oil export where we assume that the government has some monopoly power in the world oil market. The government

determines the level of oil exported regardless of is export price, thus the oil demand function is assumed to be perfectly inelastic. Finally, this model is assumed to be a short-run model where the capital stocks installed in each sector are assumed to be fixed.

The main task for this model is to derive a demand for and supply of factor and commodities in each sector and then find a solution to provide a set of wages and prices which will drive excess demands in both markets to zero. Thus, this approach will help us to analyze the performance of the Saudi Arabian economy at a disaggregated level, and can identify sector specific impacts of trade policies.

The Model

The mathematical formulation of the proposed model accommodates four markets:

Production and employment

The model distinguishes eleven sectors: agriculture, crude oil, mining, petroleum refining, manufacturing, utility, construction, trade, transportation, finance and services. Each sector produces homogeneous output Xi, using one type of capital and three types of labor, L_1, L_2, L_3, where L_1 stands for skilled labor, L_2 semi skilled, and L_3 unskilled labor. The capital input, K_1, is fixed, and the economy is assumed to be at full employment.

Production in Saudi Arabia is characterized by a

constant elasticity of substitution (CES) Production functions. This functional form permits some degree of flexibility with regard to substitution of the primary factor inputs (capital and labor).

The incorporation of three different labor skills into the production function is accomplished by nesting the CES Production function. Hence, the Saudi Arabia production function takes the following form:

$$X_1 = A_1 \left[b_1 K_1^{-\sigma_1} + (1 - b_1)(u_1 L_1^{-\sigma_1} + u_2 L_2^{-\sigma_1} + u_3 L_3^{-\sigma_1}) \right]^{-1/\sigma_1} \quad (1)$$

$$\Sigma_1 u_s = 1$$

where

X_1 = sectoral output in millions of SR

A_i = technological or scaling parameter (assumed constant)

b_1 = CES distribution parameter

σ_i = elasticity of substitution between K,L

u_1, u_2, u_3 = labor share of different categories

L_1 = skilled labor

L_2 = semi skilled labor

L_3 = unskilled labor

K_1 = sectoral capital stock in millions of SR

This function is a CES Production, which assumes some flexibility with regard to substitution of factor input (K_1,L_1). It also assumes that each sector has a constant elasticity of substitution, where the value added by the specific sector is a function of labor and capital.

Sectoral capital stocks (Ki) are assumed to be fixed in each sector representing the fact that once capital stocks, plant, and machinery are in place it is not possible to shift or move them to another location in the short run.

Labor Market

According to economic theory, we know that if production functions are specified and if factor endowments and commodity prices are given, we can compute the firm's factor demands by assuming profit maximizing behavior on the part of each firm. Hence, labor is employed up to the point where the value of the marginal product equals the nominal wage rate.

$$W_1 = PN_1 (1 - b_1) u_1 A^{-\sigma_1} (X_1/L_{11})^{1+\sigma_1} \quad (2)$$

$$W_2 = PN_1 (1 - b_1) u_2 A^{-\sigma_1} (X_1/L_{12})^{1+\sigma_1} \quad (3)$$

$$W_3 = PN_1 (1 - b_1) u_3 A^{-\sigma_1} (X_1/L_{13})^{1+\sigma_1} \quad (4)$$

With three labor categories, we will have three different wage rates:

where

W_1 = nominal wage rate for skilled labor

W_2 = nominal wage rate for semi skilled labor

W_3 = nominal wage rate for unskilled labor

We assume full employment such that :

$$\bar{L}_1 = \sum_i^n L_{i1} \quad (5)$$

$$\bar{L}_2 = \sum_i^n L_{i2} \quad (6)$$

$$\bar{L}_3 = \sum_i^n L_{i3} \quad (7)$$

Equations (5), (6), and (7) represent labor market equlibrium where total labor demanded for each labor categories is equal to total labor supply for the same labor categories which are given exogenously. $\bar{L}_1$, $\bar{L}_2$, $\bar{L}_3$ denote total labor supply for skilled, semi skilled, and unskilled labor respectively. In this case the total employment is made equal to the base year employment level (1981), and nominal wages will adjust to clear each labor market.

Foreign Trade Market

The specification of foreign trade and its interaction with the domestic economy constitutes an important part of the model. Following the most recent studies on CGE models we assume imperfect substitution between domestic production and imports. This implies that a change in import prices (PMi) will affect domestic prices(PD_i) where the size and the direction of the change depends on the degree of differentiation between imported and domestic goods, or saying it in another way it depends on the degree of substitution between the two products. Also the imperfect substitution assumption implies that different trade policies have an effect on both prices and quantities of imports, and the degree of policy effectiveness depends on the trade substitution elasticities between imports and

domestic products.

As described by Dervis, De Melo, and Robinson (1982), this product differentiation framework is a very useful one for building trade centered applied general equilibrium models. Thus, we define a composite commodity for each of the commodity categories, Qi, which is a CES function of imports Mi, and domestic goods, Di.

$$Q_i = \epsilon_i \left[\delta_i M_i^{-\beta_i} + (1 - \delta_i) D_i^{-\beta_i}\right]^{-1/\beta_i} \qquad (8)$$

Where ϵ_i, δ_i and β_i are parameters with $\mu i = 1/1+\beta_i$ denoting the trade substitution elasticity between foreign and domestic goods. Given the domestic and import prices, the problem that faces the buyer is to maximize Qi subject to a budget constraint. The solution is to find a ratio of Mi and Di so that the marginal rate of substitution between import and domestic production equals the ratio of the price of the domestically produced good to the price of the imported good. Thus, the first order condition yields:

$$M_i/D_i = \delta_i^{\mu_i} (PD_i/PM_i)^{\mu i} Q_i \qquad (9)$$

$$d_i = D_i/Q_i = (P_i/PD_i)^{\mu_i} (1 - \delta_i)^{\mu_i} \epsilon_i^{\mu_i - 1} \qquad (10)$$

where PDi denotes the domestic price of the good, and PMi denotes the price of imports. di is the ratio of domestic good to composite commodities Q_i, and P_i denotes composite commodity prices. These prices are also given by a CES function that aggregates domestic and input prices.

$$P_i = 1/\epsilon_i \left[\delta_i^{\mu_i} PM_i^{1-\mu_i} + (1 - \delta_i)^{\mu_i} PD_i^{1-\mu_i}\right]^{1/1-\mu_i} \quad (11)$$

Following the small country assumption, the import supply curves are horizontal and are represented by the following import price equation.

$$PM_i = \bar{PW}_i \ (1 + tm_i) \ . \ ER \quad (12)$$

where

PW_i = The fixed world price of imported goods in U.S. $

tm_i = Tariff rate

ER = Exchange rate (SR/U.S. $)

The small country assumption implies that Saudia Arabia is a price taker, thus we assume PW is exogenously determined. Policy makers can effect the import price expressed in domestic currency through tariff and exchange rate policies, and the values assigned to the elasticity of substitution for each of the sectors (μ_i) are important determinants of responses to these trade policies. For example, the higher the elasticity (μ_i), the less imports are affected by a tariff increase.

Exports

The assumption that domestic and foreign goods are heterogeneous leads to a downward sloping demand function for exports where in the eyes of foreign buyers Saudi Arabia exports are differentiated from the same goods provided by other suppliers. Thus, exports are determined by relative prices as follows:

$$E_1 = \bar{E}_0 \ (\pi_1/PWE_1)^{n1} \qquad (13)$$

where

n_1 = The price elasticity of export demand.

π_1 = Average world price of exports in U.S. dollars.

PWE_1 = Price of exports in U.S. dollars.

E_0 = A scaling constant.

Equation (14) defines the price of exports, PWE_1, expressed in foreign currency.

$$PWE_1 = PD_1/ER(1+te_1) \qquad (14)$$

where

te_1 = The export subsidy rate.

ER = The exchange rate.

PD_1 = The domestic price.

According to this equation, if for any reason there is an increase ın domestic production cost this will increase the domestic price (PDi) and lead to an increase in the U.S. $ price of domestic exports (PWEi). Thus, the demand for exports (Ei) will fall. On the other hand, an increase in export subsidies or a devaluation of domestic currency leads to a fall in world price of exports (PWEi) and an increase in the demand for domestic exports.

Therefore, if Saudi Arabia wants to increase its export of non-oil goods for example, it can do this through various trade policies, such an export promotion policy where such policy lowers the non-oil price of exports relative to the

world average price of export (π_1). The change in export demand resulting from a change in the domestic price of export relative to the world's price depends on the magnitude assigned to the export demand elasticity (n_1).

As we mentioned in the beginning of this chapter, Saudi Arabia has some monopoly power over world oil production. To incorporate this assumption, we will assume that the elasticity of oil export demand is equal to zero; thus we can represent the oil export demand function as follows.

$$E_{oil} = \overline{E}_{oil} \tag{15}$$

Accordingly, the export functions will take the following form:

$$E = \overline{E}_{oil} + E_{noil} \tag{16}$$

Balance of Payments

The current and capital accounts are used to define Saudi balance of payments as follows :

$$S_f = \Sigma_1 PW_1 . M_1 . ER - \Sigma_1 PD_1 . E_1 + AID + NTPI + NCTOUT + REM + DPOUTH \tag{17}$$

where

s_f = Foreign capital inflow (in millions of SR)

AID = government aid to other countries (in millions of SR).

NIPI = Net Property and Entrepreneurial income (in millions of SR)

NCTOUT = Net current transfer out the country (in millions of SR).

REM = Foreign labor remittances (in millions of SR).

DPOUTH = Direct purchases abroad by the resident household (in millions of SR).

Following our assumption of a fixed exchange rate, we assume that foreign capital inflow adjusts to allow the foreign exchange market to clear.

Accordingly, we assume that Saudi Arabia gives a fixed percentage of its income to the rest of the world. Such an assumption is realistic and Saudi Arabia gives more than seven percent of its income as aid to poor countries. Therefore, we assume the aid function will take the following form.

$$AID = ad \cdot GR \qquad (18)$$

where

ad = The base year fixed proportion.

GR = government revenue.

Income Equations

In this model we distinguish between four kinds of incomes, oil capital, non-oil capital, government and household income.

Oil Capital Income

The capital income in the oil sector (KIO) is equal to value added minus wage and indirect tax payments.

$$KIO = \sum_{j=2,4} v_j . PD_j X_j - \Sigma_s \Sigma_{j=2,4} L_s . W_s - \sum_{j=2,4} td_j . PD_j . X_j \quad (19)$$

$$- g_1 . PD_4 X_4$$

where,

v_j = sectoral per unit value added. ($v_j = 1 - \sum_{i=1}^{n} a_{ij}$) in both oil and petroleum refining sectors where 2 and 4 stand for the order of both sectors in the input-output table.

td_j = indirect tax rate on oil sector.

g_1 = the adjustment parameter for oil income.

Non-oil Capital Income

The second type of income is non-oil capital income, which can be defined similarly as follows:

$$KINO = \sum_{j=2,4} v_j . PD_j X_j - \Sigma_s \Sigma_{j=2,4} L_s . W_s - \sum_{j=2,4} td_j . PD_j . X_j \quad (20)$$

$$- g_2 . PD_j X_j$$

where

g_2 = non oil income adjustment parameter

Household Income

Since the issue of income distribution is not a matter of concern in this study, household income is not categorized and therefore is represented by a single consumer who receives payments from factors used in production and government transfers.

Payments from the government are assumed to be exogenous. Thus household income (HI) is defined as

follows:

$$HI = GDP - KIO - KINO - NTPI - GTH - NINX \quad (21)$$

where

GDP = Gross Domestic Product

GTH = Government Transfers to households.

NINX = Net indirect tax.

Gross Domestic Product (GDP) can be defined as follows:

$$GDP = \Sigma_j PD_j X_j - \Sigma_j \Sigma_i a_{ij} (PD_j X_j) + \Sigma_j PW_j tm_j M_j + W_g \quad (22)$$

where

W_g = Direct payments to government employees.

NET indirect taxes (NINX) are defined as follows.

$$NINX = \Sigma_j tm_j M_j PW_j ER - \Sigma_j td_j X_j \quad (23)$$

where

td_i = indirect tax rate

Government Income

We simply treat government as an agent that collects taxes and transfers them to consumers in the form of subsidies and services. Thus, we assume that government income includes tariffs, income taxes, and return on its invested capital outside the country.

$$GR = \Sigma_j tm_j PW_j ER + t_1 \Sigma_{j=2,4} PD_j E_j + t_2 KINO$$

$$+ t_3 HI + \overline{GIEOUT} \quad (24)$$

where

t_1 = government tax rate on oil exports

t_2 = government tax rate on non-oil income.

t_3 = government tax rate on household incomes.

$\overline{GIEOUT}$ = government interest earnings on its investment outside the country.

Investment and Saving

Following the classical economic theory, we assume that investment is saving driven where total fixed investment equals the sum of household government, oil, non-oil, and foreign savings minus change in stocks.

$$T_{inv} = S_{gov} + S_H + S_{oil} + S_{noil} + S_f - CHST \quad (25)$$

where

T_{inv} = Total fixed investment.

S_{gov} = government savings.

S_H = household savings.

S_{oil} = oil savings

S_{noil} = non-oil savings.

S_f = Foreign savings.

CHST = Change in Stock.

Government and household savings can be expressed as a fixed proportion of their corresponding income as follows:

$$S_{gov} = sg\ GR \quad (26)$$

$$SH = sh\ HI \quad (27)$$

where sg and sh are the marginal propensity to save for both government and households where they are assumed to be fixed.

The other remaining savings for oil and non-oil sectors are derived from the social accounting matrix as follows:

$$S_{oil} = KIO - t_1.\Sigma_{j=2,4} E_j - OTOUT \quad (28)$$

$$S_{noil} = KINO + GTNOIL - t_2 KINO - NOTOUT \quad (29)$$

where

OTOUT = oil transfers to the rest of the world

GTNOIL = Government transfers to non-oil sectors

NOTOUT = Non-oil transfers to the rest of the world.

Finally after determining the total level of investment in the economy, we now need to determine the investment demand function in each sector of the economy. This can be done by assuming that each sector's share of total investment is fixed so that

$$Inv_i = z_i.TINV \quad (30)$$

where

zi = the sectoral investment fixed share.

Household Consumption

Sectoral household demand for each comodity (i) is assumed to be a fixed share (Qi) of aggregate household consumption.

Thus: $CH_i = Q_i\ CH$ (31)

where CH_i is the total household consumption which can be specified as a fixed share of household disposable income (H_i) as follows:

$$CH = (1 - S_h - t_3).HI - HTOUT \quad (32)$$

Government consumption

We make two assumptions in regard to government consumption. First, we assume that the government keeps the level of its expenditure on each commodity fixed. Second, we assume that the government gives aid to other third world countries in the form of domestic products. Hence, the government expenditure on commodity i is equal to:

$$CG_i = r_i.CG \quad (33)$$

where

ri = The base year fixed expenditure share spend on good (i).

CG = the total government consumption.

where total government consumption is given by:

$$CG = GR-W_g-GTNOIL-GTH-S_{gov}GR+\Sigma_j td_j(PD_j\ X_j)-ad\ GR \quad (34)$$

Intermediate demands

Intermediate demand is determined through a Leontief function as follows:

$$v_{ij} = a_{ij}X_j \quad (35\text{-}a)$$

where aij are input-output coefficients. By aggregating

equation (35-a) we get the total intermediate demand by sector of origin:

$$v_i = \Sigma_j v_{ij} \qquad (35\text{-b})$$

Product Market Equilibrium

The general equilibrium is defined as a set of domestic prices that equates sectoral demand for commodity i with sectoral supply of commodity i. By using the domestic use ratio, di, we can build up corresponding sectoral consumption demand and investment demand functions for the domestic economy. Each of these demands depends on relative prices, including the exchange rate and wages. Thus, the domestic demand function for domestically produced goods takes the following form:

$$D_i = d_i V_i + d_i CH_i + d_i CG_i + d_i Z_i \qquad (36)$$

To obtain total demand for domestically produced commodities (Xi^d), we add exports to domestic demand, thus:

$$X_i^d = d_i V_i + d_i CH_i + d_i CG_i + d_i Z_i + E_i \qquad (37)$$

Subtracting the sectoral aggregate supply functions from sectoral aggregate demand functions gives us n excess demand functions. In order to have a general equilibrium solution these n equations must equal to zero.

$$0 = X_i^d - X_i^s \qquad (38)$$

According to Walras Law, there is a functional

dependency in the system. Thus, if n-1 excess demands are zero, then the nth excess demand must also be zero, which indicates that we can only solve for relative prices. Therefore, in order to close the system, some sort of a normalization rule is required. Thus, a normalization equation is introduced in this model by using a consumer price index as anumeraire, hence all nominal variables have to be interpreted relative to the price index as follows:

$$\Sigma_i \ \Omega_i \ P_i = \overline{P}$$

where

Ω_i[1] = the weights for the price index ($\Sigma_i \ \Omega_i = 1$).

$\overline{P}$ = the price level.

By adding the equation of the numeraire to the system, the model will not solve for the inflation rate but rather for relative prices and sectoral output, thereby implicitly assuming that the authorities adjust money supply to maintain a constant price level.

Data

Most of the data that is needed to estimated for the parameters needed for the (CES) production functions such as elasticities of substitution between labor and capital share, and the distribution parameter are not available. Since most of the empirical studies about the elasticity of substitution between labor and capital ın developing

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[1] The weights used Ω_i are the commodity shares in the value of domestic production.

countries produced estimates between 0.5 and 1.3 (L. White, 1978), we assume the value for Saudi Arabia is 1.2 for traded sectors and 0.7 for other sectors (Table 3.1).

Following Alsabah's (1985) study of Kuwait, we assume the value of the Saudi trade elasticity of substitution is 2.5 for traded sectors and 0.5 for non-traded sectors (Table 3.2).

Finally, the values of the export demand elasticities are based on some studies that were done on the Saudi economy. Table (3.3) shows that the values of n_1 are assumed 2.0 for exportable sectors and 0.5 for the petroleum refining sector. As mentioned in the beginning of this chapter, Saudi Arabia has some monopoly power over world oil production. To incorporate this assumption, it is assumed that the elasticity of oil export demand is equal to zero.

Through the model outlined above, we study the general equilibrium effects associated with import tariffs and exchange rate devaluation on various micro and macro variables. Initially, we ran the model for 1981 to obtain a benchmark. The model is calibrated so that actual data values for that year are obtained. We then alter the tariff rates, exchange rate, and subsidy rates and analyze their effects on the economy. The resulting equilibrium values are then compared with in the benchmark values in order to quantify the policy effects. The benchmark and simulation results are presented in Chapter V.

TABLE 3.1

ELASTICITY OF SUBSTITUTION
BETWEEN K_1 and K_i

Sector	σ_1
Agriculture	1.2
Crude Oil	1.2
Mining and Quarrying	1.2
Petroleum Refining	1.2
Manufacturing	1.2
Utility	0.7
Construction	0.7
Trade	0.7
Transportation	0.7
Finance	0.7
Community Social and Personal Services	0.7

TABLE 3.2

TRADE SUBSTITUTION ELASTICITIES

Sector	u_1
Agriculture	2.5
Crude Oil	0.5
Mining and Quarrying	2.5
Petroleum Refining	0.5
Manufacturing	2.5
Utility	0.5
Construction	0.5
Trade	0.5
Transportation	2.5
Finance	0.5
Community Social and Personal Services	0.5

TABLE 3.3

EXPORT DEMAND ELASTICITIES

Sector	n_1
Agriculture	2.0
Crude Oil	0.0
Mining and Quarrying	2.0
Petroleum Refining	0.0
Manufacturing	2.0
Utility	0.0
Construction	0.0
Trade	0.0
Transportation	2.0
Finance	2.0
Community Social and Personal Services	0.0

CHAPTER V

THE EFFECT OF POLICY SIMULATION ON THE SAUDI ECONOMY

Through the model outlined in Chapter III, we will study the general equilibrium effects of various trade and incentive policies aimed at diversifying the economic structure of Saudi Arabia. In addition, we will study the effect of a decrease in oil exports on Saudi major economic variables. Finally, we will compare the above policies to the free trade case, and test the theoretical arguments of the supremacy of free trade over trade distortion policies.

Thus, the model will be solved for five different experiments as follows:

Isolated policies

where we will study the affects of each of the following policies:

(1) The effect of an 8 percent devaluation of the domestic exchange rate currency.

(2) The effect of an 8 percent increase in tariffs on imports.

(3) The effects of a free trade policy.

(4) The effect of a 5 percent decrease in oil exports.

Combined Policies

We study effect of a combination of trade policies which include:

(a) 8 percent reduction (depreciation) in domestic exchange rate currency.

(b) 5 percent increase in tariff on all sectors except sectors 1, 2 and 5.

(c) 10 percent increase in export subsidies on all sectors except sectors 1 and 2.

The base year solution will be used as a benchmark equilibrium to test the effects of each experiment.

Isolated policy (1)

In this experiment we devalue the domestic currency by 8 percent. Such a policy affects the Saudi economy through changes in relative prices which alters the demand for both domestic and foreign goods and affects the resource allocation among the different economic sectors.

Domestic Prices

Exchange rate devaluation is expected to increase the prices of domestic goods, and that is exactly what happened as it shows in table 4.1, where all domestic prices increased. The highest increase was for the construction sector whose price increased by 8 percent. This is equal to the increase in the exchange rate. On the other hand, the lowest increase was for the manufacturing sector where

domestic prices increased by only 1.5 percent.

Exports

Since the change in the exchange rate is greater than the change in domestic prices, the net effect is a decrease in domestic prices of exported goods. This is by the equation (14). Table 4.1 shows that all domestic prices of exported goods decreased. The prices of manufacturing goods have experienced the largest decrease of 6.03 percent. The assumptions that Saudi Arabia is a small country can be translated to a downward sloping export demand curve where any decrease on export prices will lead to the increase in demand for Saudi exported goods. This relationship is governed by equation (15). Table 4.1, shows that the manufacture sector received the highest increase in export demand, 13.41 percent, followed by the agriculture and trade sectors. The assumption of constant oil export, is reflected in Table 4.1 by the zero change in export demand for oil. The exports of non-oil sectors increased by 9 percent which indicates that devaluation policy is an effective policy that encourages or stimulates non-oil exports. Thus, devaluation is an effective policy in terms of diversifying the sources of foreign exchange.

Imports

Following our assumption of a small country, we assume a linear relationship between domestic price of imports and the exchange rate as given by equation (16). Table 4.2

TABLE 4.1

ISOLATED POLICY(1) : PERCENTAGE CHANGE IN SECTORAL DOMESTIC AND EXPORT PRICES

Sector	PD	PE	E
Agriculture	3.52	-4.14	9.07
Crude Oil	3.52	-4.24	0.00
Mining and Quarrying	6.55	-1.35	2.78
Petroleum Refining	5.51	-2.30	1.17
Manufacturing	1.50	-6.03	13.41
Utility	3.50	-4.18	0.00
Construction	8.00	-0.03	0.00
Trade	5.12	-2.66	5.65
Transportation	5.73	-2.09	4.40
Finance	4.50	-3.24	6.91
Community Social and Personal Services	3.56	-4.10	0.00

shows that across all sectors domestic prices of imports increased by 8 percent which equals the rate of foreign exchange devaluation.

The assumption of imperfect substitution between domestic and foreign goods implies that an increase in import prices will lead importers to substitute domestically produced goods for foreign goods. Therefore the increase of prices of imported goods expressed in domestic currency will decrease demand for imported goods as shown in table 4.2. Imports of the manufactured goods show the smallest decrease of 1.28 percent. This reflects the fact that the Saudi manufacturing sector depends heavily on imports of inputs, parts, and machines which cannot be produced domestically because of technical or financial problems. Table 4.2 also shows that imports of agricultural goodsdecreased by almost 5 percent, which reflects the high substitutability between domestic and imported agricultural goods.

Trade Balance

We assume that the balance of payment is always in equilibrium. In addition, we assume a fixed exchange rate. Thus, devaluation will affect the value of both exports and imports, and the adjustment in the balance of payment will be through the change in foreign saving (sf). Table 4.5 shows that foreign saving (sf) decreases by 4 percent.

Resource Allocation

Devaluation as shown by Table 4.3 changes domestic

TABLE 4.2

ISOLATED POLICY(1) : PERCENTAGE CHANGE IN SECTORAL IMPORT

Sector	PM	M
Agriculture	8.0	-4.95
Crude Oil	8.0	0.00
Mining and Quarrying	8.0	-2.75
Petroleum Refining	8.0	0.00
Manufacturing	8.0	-1.28
Utility	8.0	0.00
Construction	8.0	0.00
Trade	8.0	0.00
Transportation	8.0	-5.38
Finance	8.0	0.00
Community Social and Personal Services	8.0	0.00

prices of factors and commodities. Such changes affect resource allocations which in turn affect consumption and investment.

The increase in domestic prices of exports reallocates resources towards domestic sectors which produce exported goods. Moreover, the decrease in the domestic prices of imported goods allocates resources towards domestic sectors which produce import competitive goods. Thus, aggregate domestic production increases. Table 4.3 shows that total domestic output increased by 0.03 percent. The effect on sectoral production is varied. While some sectors experienced output increases, others experienced output decreases. Included in the latter group are agriculture, manufacturing, utilities, and finance. The smallest decline in output was in the manufacturing sector, whose output declined by 3.4 percent.

To understand the effect of devaluation on domestic production and why some sectors experienced an increase in output while others experienced a decline, we need to look at the change in two other sets of variables, net prices and nominal wage rates.

Net Prices

The change in net prices depends on changes in domestic prices where there is a positive relation between the two. Domestic prices increased in all sectors, except the manufacturing sector whose price decreased by 4.38 percent (see Table 4.4). This reflects the fact that devaluation

TABLE 4.3

ISOLATED POLICY(1) : PERCENTAGE CHANGE IN SECTORAL DOMESTIC OUTPUT AND PRICES

Sector	X	PD
Agriculture	-0.06	3.52
Crude Oil	0.064	3.43
Mining and Quarrying	1.67	6.55
Petroleum Refining	0.50	5.51
Manufacturing	-3.41	1.51
Utility	-0.08	3.50
Construction	0.31	7.97
Trade	0.08	5.12
Transportation	0.12	5.73
Finance	0.06	4.50
Community Social and Personal Services	-0.34	3.56

increased the price of imported inputs (a_{ij}) which the manufacturing sector depends on.

Wage rates

Devaluation affects wage rates, where all wages increased by an average rate of 2.62 percent. Such an increase in both wages and net prices affects real wage rates. Thus, in the manufacturing sector where the net price decreased by 4.38 percent and was not reversed by an increase in the nominal wage the real wage (W/PN) increased significantly. This in turn decreased the demand for labor in the manufacturing sector, as seen clearly in Table 4.4, where the total labor force in this sector decreased by 11.67 percent. The decrease in manufacturing output is therefore a result of its high dependence on imports and the resulting increase in costs resulting from devaluation.

Income

The increase in domestic prices and wages translates into an increase in household income where the income for these groups increased by 3 percent. This increase in household income implies an increase in direct tax collection. This explains the 0.8 percent increase in government income shown in Table 4.5.

Consumption

The increase in both household and government income increases both household and government consumption. Table

TABLE 4.4

ISOLATED POLICY(1) : PERCENTAGE CHANGE IN SECTORAL DOMESTIC NET PRICES AND TOTAL LABOR

Sector	PN	L
Agriculture	2.40	-0.327
Crude Oil	3.39	0.49
Mining and Quarrying	5.84	4.95
Petroleum Refining	5.12	2.91
Manufacturing	-4.38	-11.67
Utility	0.53	-1.81
Construction	9.05	1.043
Trade	4.87	1.013
Transportation	4.99	1.014
Finance	3.67	0.55
Community Social and Personal Services	0.66	-1.80

TABLE 4.5

ISOLATED POLICY(1) : PERCENTAGE CHANGE IN SOME MACROECONOMIC VARIABLES

Variables	Percentage Change
HI	3.0
GR	0.8
CH	3.0
CG	0.94
GDP	3.90
Sf	-4.0

4.5 shows that household consumption increased by 3 percent. This is equal to the percentage increase in income. It shows that there is a one to one relationship between household income and its consumption. On the other hand, government consumption increased by 0.94 percent. As a result, consumption, investment, and export demand, increased. Thus to restore equilibrium in the product market, aggregate supply increased by 0.03 percent.

Finally, if we look at the percentage change in the sectoral output/labor ratio (X/L), we find that this rate is greater than one in agriculture sector which indicates that labor productivity improved in these sectors (table 4.6).

Isolated Policy (2)

In this experiment we increase tariffs across all sectors by 8 percent. Such an increase affects the price of both imported and domestic goods. The small country assumption results in an increase in import prices in all sectors by the full amount of the tariff change (8 percent). These change can be seen in Table 4.7. Accordingly, imports of foreign goods decrease. The greatest decrease was for the transportation sector, where imports decreased by 12.64 percent, followed by a decrease in imports for the agricultural and mining sectors by 6.43 percent. Imports of manufacturing goods showed the lowest decrease, only 1.75 percent. This, like the previous experiment showed, reflects the fact that the manufacturing sector is highly dependent

TABLE 4.6

ISOLATED POLICY(1) : PERCENTAGE CHANGE IN SECTORAL DOMESTIC OUTPUT AND LABOR PRODUCTIVITY

Sector	X	L	X/L
Agriculture	-0.06	-0.327	1.83
Crude Oil	0.06	0.49	0.12
Mining and Quarrying	1.67	4.95	0.33
Petroleum Refining	0.50	2.91	0.17
Manufacturing	-3.41	-11.67	0.29
Utility	-0.08	-1.81	0.04
Construction	0.31	1.043	0.28
Trade	0.08	1.013	0.08
Transportation	0.12	1.014	0.12
Finance	0.06	0.55	0.11
Community Social and Personal Services	-0.34	-1.80	0.19

TABLE 4.7

ISOLATED POLICY(2) : PERCENTAGE CHANGE IN SECTORAL IMPORT

Sector	PM	M
Agriculture	1.08	-6.43
Crude Oil	1.08	0.00
Mining and Quarrying	1.08	-6.33
Petroleum Refining	1.08	0.00
Manufacturing	1.08	-1.75
Utility	1.08	0.00
Construction	1.08	0.00
Trade	1.08	0.00
Transportation	1.08	-12.64
Finance	1.08	0.00
Community Social and Personal Services	1.08	0.00

on imported inputs that cannot be substituted by domestic goods in the short run.

Exports

An increase in tariffs has a mild effect on domestic output prices, where domestic prices increased in all sectors except agriculture, manufacturing and the refinery sectors. The manufacturing sector experienced the greatest decrease in domestic output prices with a decrease of 6.11 percent. Equation (14) shows that there is a positive relationship between domestic and export prices. Table 4.8 shows that export prices has increased in all sectors except agriculture, oil and manufacturing. The manufacturing sector experienced the greatest decrease with 6.11 percent.

Thus, there is an identical change in both domestic and export prices, and the reason for this is our assumption of a fixed exchange rate. Therefore, as it is shown in equation (14), with a downward sloping export demand function, a decrease in export price will bring an increase in export of Saudi commodities. Table 4.8 shows that again the manufacturing sector has the highest increase in exports with 13.6 percent. This is followed by an increase in agricultural sector exports of 1.06 percent, while the rest of the sectors experienced a decline in export demand (Table 4.8). The assumption of zero export demand elasticities for oil implies that oil exports are independent of the change in tariff or exchange rate policies.

Trade balance

From the above result we see that increasing tariffs has a great effect on imports. Aggregate imports decreased by 3 percent, while it had little effect on aggregate exports which increased by 0.01 percent. Thus, the increase in the value of exports and the decrease in the value of imports were not enough to bring equilibrium to the trade balance account, which experienced a deficit. Therefore, capital flows adjust to bring equilibrium to the balance of payments. Table 4.8 shows that there is a 2 percent increase in foreign saving (sf), or in other words, there is 2 percent increase in capital inflow.

Resource allocation

Increasing tariffs has a great impact on relative prices where import price increases result in a reallocation of resources towards those sectors which produce domestic imports of competitive goods. Table 4.9 shows that domestic production increased for all sectors. Manufacturing output has the highest decline with a rate of 7.12 percent where aggregate output has a slight decline of 0.03 percent.

To analyze the effect of tariffs on factor movements and utput across sectors, we need first to analyze the effects of tariffs on net prices and nominal wage rates.

Net Prices

From micro theory we know that each producer tries to

TABLE 4.8

ISOLATED POLICY(2) : PERCENTAGE CHANGE IN DOMESTIC AND EXPORT PRICES

Sector	PD	PE	E
Agriculture	-0.42	-0.42	1.06
Crude Oil	-1.47	-1.47	0.00
Mining and Quarrying	2.58	2.58	-4.93
Petroleum Refining	-0.27	-0.27	0.13
Manufacturing	-6.11	-6.11	13.6
Utility	0.3	0.3	0.00
Construction	3.9	3.9	0.00
Trade	1.16	1.16	-2.18
Transportation	1.57	1.57	-2.98
Finance	1.01	1.01	-1.89
Community Social and Personal Services	0.05	0.05	0.00

TABLE 4.9

ISOLATED POLICY(2) : PERCENTAGE CHANGE IN DOMESTIC OUTPUT AND NET PRICES

Sector	X	PN	W^a/PN
Agriculture	0.05	-1.76	1.31
Crude Oil	0.09	-1.51	1.52
Mining and Quarrying	1.78	0.70	-3.30
Petroleum Refining	0.11	-1.60	1.44
Manufacturing	-7.12	-16.60	0.14
Utility	-0.013	-2.61	0.88
Construction	0.33	4.11	-0.56
Trade	0.136	0.72	-3.20
Transportation	0.12	-0.14	16.50
Finance	0.166	0.07	-33
Community Social and Personal Services	-0.19	-3.22	0.71

maximize his profit rate. Thus, if net prices increase, this means there will be a possibility for a higher profit rate and higher production, and vice versa. Table 4.9 shows that net prices decreased in most of the sectors except the mining, manufacturing, utility and service sectors. The greatest decline is for the manufacturing sector where net prices decreased by 16.6 percent. This explains the decrease in demand for labor by an average rate of 2.3 percent and the increase in the real wage rate (W/PN). Consequently, the labor demand in the manufacturing sector experienced a 23.3 percent decrease. The result is a decline in manufacturing output.

Income

According to trade theory, tariffs have a negative effect on consumer welfare. Tarıffs increase the prices of consumption goods which redistributes real income away from consumer groups. The results of the policy simulation presents in Table 4.10 support such an argument. Nominal wages fall which decreases real household income by 0.7 percent. Government income increased by 2.2 percent. The increase in government income results from the 8 percent increase in tariffs on imported goods.

Consumption

As we mentioned before, there is a one to one relationship between household income and consumption. Table 4.11 shows that household consumption decreased by 0.7

TABLE 4.10

ISOLATED POLICY(2) : PERCENTAGE CHANGE IN DOMESTIC TOTAL LABOR FORCE

Sector	L
Agriculture	0.23
Crude Oil	0.8
Mining and Quarrying	-3.34
Petroleum Refining	-19.0
Manufacturing	-23.3
Utility	4.75
Construction	2.13
Trade	31.10
Transportation	1.52
Finance	1.70
Community Social and Personal Services	-1.05

percent, which equals the rate of decline in household incomes. On the other hand, the increase in government income lead its consumption to increase by 4 percent.

Investment

Government and household incomes determine the level of investment. As a result, the decrease in household income caused its saving to decrease by 9.5 percent. On the other hand, the increase in government income caused its saving to increase by 11 percent. Thus, the net result is an increase in total investment by 4 percent.

Finally, Table 4.11 shows that gross domestic product (GDP) increased by 0.7 percent. This table also shows that production in non-oil sectors increased by 9 percent. In addition, the exports of the non-oil sectors increased by 2.4 percent, where the manufacture sector had the highest share of non-oil exports. Despite the decline in aggregate output, non-oil output increased by 1.5 percent.

Isolated Policy (3)

According to the theories of international trade, free trade is superior to protected trade, specially for small countries. But these theories assume a purely competitive world market, and this assumption is not fulfilled in reality. For example, some countries give export subsidies to encourage its exports. Some big companies try to find a market for their product. Thus, they use a dumping strategy to weaken other competitive producers. Therefore, some

TABLE 4.11

ISOLATED POLICY(2) : PERCENTAGE CHANGE IN SOME MACROECONOMIC VARIABLES

Variables	Percentage Change
HI	-0.7
GR	2.2
CH	-0.7
CG	4.0
GDP	0.7
Sf	2.0
TINV	4.0
W^a	-2.3

small countries, in an endeavor to protect their infant industries, find it necessary to promote some measures such as subsidies, tariff....etc, to compete in the world market.

Therefore, in this study we will first analyze the effects of a free trade policy on the Saudi economy. Then we compare the result of this policy with results of other trade policies.

In this study, we define a free trade policy as no-tariffs no-subsidies. Eliminating all tariffs and subsidies in the economy alters relative prices which in turn affects production and income.

Domestic Prices and Production

The elimination of tariffs is expected to decrease domestic prices. On the other hand, the elimination of subsidies will have the opposite effect on domestic prices. Table 4.12 shows that domestic prices increased in most of the sectors where the highest increase was in the manufacturing sector with a rate of 3.64 percent. The construction sector had the highest rate of decline of 1.64 percent. These price movements affected output, where manufacturing output increased by 3.54 percent, almost equivalent to its price increase. On the other hand, domestic production in the other sectors experienced a slight rate of decline where the highest decline was in the construction sector. This finding supports the fact that imported goods are a highly competitive with domestic goods

TABLE 4.12

ISOLATED POLICY(3) : PERCENTAGE CHANGE IN DOMESTIC AND EXPORT PRICES

Sector	PD	PE
Agriculture	0.4	0.4
Crude Oil	1.06	1.06
Mining and Quarrying	-0.96	-0.96
Petroleum Refining	0.3	0.3
Manufacturing	3.64	3.64
Utility	0.11	0.11
Construction	-1.64	-1.64
Trade	-0.29	-0.29
Transportation	-0.29	-0.29
Finance	-0.21	-0.21
Community Social and Personal Services	0.22	0.22

either because of higher quality or because of foreign dumping.

Exports

Table 4.12 shows that the change in the prices of domestic exports was parallel to the change in domestic prices. They increased at the same rate. These results can be explained by equation (14), which shows that with no-subsidies and no change in exchange rate, domestic export prices will equal domestic prices. Table 4.13 shows that exports in the mining, trade, transportation, and finance sectors increased, while exports of the agriculture, oil refinery, and manufacture sectors declined by 0.6, 0.14 and 6.77 percent respectively. These results show that most of Saudi infant industries can't compete in world markets, and this may support the private sector's demand for short term protection. The government urges the private sector to invest in industries when it is possible to take advantage of economies of scale which decreases the cost and enables domestic producers to compete in the world market.

Imports

Tariff removal reduces the prices of imports as can be seen in Table 4.14. Since originally tariffs were only on three sectors, agriculture, mining and manufacturing sectors only the prices of these sectors experienced a decline while the prices of other sectors didn't change. Therefore, only the imports of these three sectors changed. Table 4.14

TABLE 4.13

ISOLATED POLICY(3) : PERCENTAGE CHANGE IN SECTORAL EXPORT

Sector	E
Agriculture	-0.60
Crude Oil	0.00
Mining and Quarrying	1.98
Petroleum Refining	-0.14
Manufacturing	-6.77
Utility	0.00
Construction	0.00
Trade	0.68
Transportation	0.65
Finance	0.51
Community Social and Personal Services	0.00

TABLE 4.14

ISOLATED POLICY(3) : PERCENTAGE CHANGE IN SECTORAL IMPORT

Sector	PM	M
Agriculture	-1.95	2.74
Crude Oil	0.00	0.00
Mining and Quarrying	-1.96	2.0
Petroleum Refining	0.00	0.00
Manufacturing	-2.35	0.77
Utility	0.00	0.00
Construction	0.00	0.00
Trade	0.00	0.00
Transportation	0.00	0.18
Finance	0.00	0.00
Community Social and Personal Services	0.00	0.00

shows that imports in these sectors increased, where the highest increase was for the agriculture sector with a rate of 2.74 percent. Manufacturing imports increased by 2.77 percent. In aggregate, total imports increased by 0.8 percent.

Trade Balance

The changes in exports and imports resulted in a trade surplus. In order to restore equilibrium in the balance of payments, capital outflows adjust. As a result, foreign saving decreased by 2 percent. Although the export of non-oil sectors experienced a decline of 0.2 percent, we still have a trade surplus. One of the reasons behind this surplus is the decline in import prices.

Income

The free trade policy affects income through changing factor and domestic output prices. Table 4.15 shows that all nominal wages increased by an average rate of one percent. With the assumption of a fixed labor endowment, this results in an increase in household income of 0.5 percent. While the increase in oil prices increased government income, the elimination of tariffs on import had a negative impact on government income. As a net result, government income decreased by 0.1 percent.

Consumption

The linear relation between household consumption and

TABLE 4.15

ISOLATED POLICY(3) : PERCENTAGE CHANGE IN SOME MACROECONOMIC VARIABLES

Variables	Percentage Change
HI	0.5
GR	-0.1
CH	0.5
CG	-1.7
TINV	-2.0
X_{noil}	0.2
E_{noil}	-0.2
GDP	0.07

income implies that household consumption follows the direction of the change in income. Table 4.15 shows that household consumption increased by 0.5 percent while government consumption declined by 1.7 percent.

Investment

Although the saving of oil and non-oil sectors increased, total savings decreased. This was a consequence of a 2 percent decline in foreign saving. As a result, total investment decreased by 2 percent.

Finally, if we look at the same diversification indicators, such as the non-oil output, non-oil exports and the GDP, we find that output in non-oil sectors increased by 0.2 percent, while the exports of the same sectors experienced a decline by the same rate. This result shows that the decline in export demand of non-oil sectors has been fully compensated by an increase in domestic demand. Finally, free trade shows a positive impact on nominal GDP which increased by 0.07 percent.

Isolated Policy (4)

In this experiment we want to test the dependence of the Saudi economy on oil. We test the effect of a 5 percent decrease in Saudi oil exports on Saudi major economic variables, such as output, imports, exports, balance of payment and income. We will start our analysis by studying the effect on domestic prices and output.

Domestic prices and output

Decreased oil exports creates an excess supply of oil. Therefore, the domestic oil price adjusts to restore equilibrium in this sector. As a result, the oil price decreased by 13.6 percent, as shown in table 4.16. Domestic prices for other sectors increased at different rates. The decrease on oil export led the economy to experience a shortage of foreign exchange on which the country depend for its imports, thus manufacturing imports decreased. Hence, the domestic price of the manufacturing sector increase by 21.76 percent. This is followed by the agriculture sector with a 9.1 percent increase.

Nominal wages for different labor skills increased by an average rate of 14.11 percent. Therefore, real wages experienced an increase in all sectors, except the manufacture sector, where real wages declined. This was mainly because of the high increase in the manufacturing net price of 41.8 percent, as shown in table 4.16. Also, real wages in the service sector decreased. Accordingly, labor demand increased in the manufacturing sector by 74 percent, and in the service sector by 0.66 percent. As a result, output in both sectors increased by 10.7 percent and 0.13 percent. While other sectors experienced output declines, the greatest was the oil sector which declined by 4.4 percent (table 4.17).

TABLE 4.16

ISOLATED POLICY(4) : PERCENTAGE CHANGE IN DOMESTIC AND NET PRICES

Sector	PD	PN	W^a/PN
Agriculture	9.10	13.78	2.40
Crude Oil	-13.60	-13.76	-2.54
Mining and Quarrying	6.76	12.20	15.65
Petroleum Refining	5.54	7.50	88.13
Manufacturing	21.76	41.8	-66.24
Utility	7.14	14.36	-1.76
Construction	6.26	10.22	38.06
Trade	7.41	8.51	65.80
Transportation	5.16	4.22	334.3
Finance	6.46	8.75	61.25
Community Social and Personal Services	8.10	15.41	-8.43

TABLE 4.17

ISOLATED POLICY(4) : PERCENTAGE CHANGE IN SECTORAL OUTPUT AND TOTAL LABOR FORCE

Sector	X	L
Agriculture	-0.115	-0.55
Crude Oil	-4.40	-32.38
Mining and Quarrying	-1.51	-4.58
Petroleum Refining	-1.67	-9.34
Manufacturing	10.7	74.37
Utility	-0.01	-0.50
Construction	-0.22	-3.29
Trade	-0.28	-4.40
Transportation	-0.22	-2.89
Finance	-0.41	-66.09
Community Social and Personal Services	0.13	0.66

Exports

The change in domestic prices translates to an identical change in export prices, where the relationship between the two prices can be explained by equation (14). Table 4.18 shows that there is an increase in the price of exports across all sectors except the oil sector, whose price decreased by 13.6 percent. As a result, the exports of almost all sectors experienced a decline. According to our assumption, oil exports decreased by 5 percent. The highest decrease was in the manufacture sector, where exports decreased by 32.45 percent, followed by the agriculture sector with a decrease of 15.79 percent. The effect on the export of the rest of the sectors can been seen in table 4.18.

Import

Table 4.18 shows that reducing oil exports had no effect on prices of imports. Despite this, import increased for all importable goods. Table 4.18 shows that the mining sector had the highest import increase rate of 14.8 percent, followed by the trade sector with an increase of 12.5 percent, then the agriculture sector with an increase of almost 10 percent. Although the domestic output of the manufacturing sector experienced a high jump of 10.7 percent, its imports increased by 2.85 percent. This indicates that this sector is dependent on imports for its raw materials and machines.

TABLE 4.18

ISOLATED POLICY(4) : PERCENTAGE CHANGE IN SECTORAL IMPORT AND EXPORT

Sector	PE	PM	E	M
Agriculture	9.10	0.00	-15.79	9.96
Crude Oil	-13.60	0.00	-5.00	0.00
Mining and Quarrying	6.76	0.00	-12.23	14.79
Petroleum Refining	5.54	0.00	-2.65	0.00
Manufacturing	21.76	0.00	-32.45	2.85
Utility	7.14	0.00	0.00	0.00
Construction	6.26	0.00	0.00	0.00
Trade	7.41	0.00	-13.24	0.00
Transportation	5.16	0.00	-9.51	12.51
Finance	6.46	0.00	-11.69	0.00
Community Social and Personal Services	8.10	0.00	0.00	0.00

Trade Balance

The 5 percent decline in oil export resulted in a deterioration in the Saudi trade balance. Total exports decreased by 5 percent while imports increased by 3.4 percent. Thus, foreign savings increased to compensate for the decline in the trade balance. Therefore, foreign savings increased by 41 percent. These results confirm the Saudi economy is dependence on oil exports for its needed foreign exchange.

Income

As expected the decline in oil exports affects government income since oil revenue represent the major component of government income. Table 4.19, which shows a decrease in government income of 9.5 percent, corroborates this. On the other hand, household income increased by 10 percent. This is a result of the increase in wages and domestic prices.

Consumption

Table 4.19 shows that there is a one to one relationship between household income and consumption, where household consumption has increased by 10 percent. As a result of the decrease in its income by 9.5 percent, government consumption of goods and services decreased by 9.1 percent.

TABLE 4.19

ISOLATED POLICY(4) : PERCENTAGE CHANGE IN SOME MACROECONOMIC VARIABLES

Variables	Percentage Change
HI	10.0
GR	-9.50
CH	10.0
CG	-9.10
GDP	-10.0
Sf	41.0
TINV	8.40

Investment

Although there was a decline in oil and government saving, the increase in both household and foreign saving led to an increase in total saving and thus in total investment, which increased by 8.4 percent (Table 4.19).

Finally, Table 4.19 shows that the decrease in oil export had a negative effect on Saudi GDP which declined by 10 percent. Also, it affected the production of non-oil sector, which decreased by 18 percent.

The above results confirm the fact that the Saudi economy is highly dependent on oil sector exports, in terms of government income, output, and foreign exchange.

Combined Policies

In this experiment we devalue the domestic currency by 8 percent, increase tariff on all sectors by 5 percent except agriculture, oil and manufacturing, and increase export subsidies by 10 percent in all sectors except sector 1 and 2.

The simulation results of this policy indicate that the combined policy is superior to previous simulation policies in terms of the change in trade balance, income, investment,non-oil output, and consumption.

Domestic Prices

In this experiment, all domestic prices increase at a very high rate. As shown in table 4.20, the manufacturing

TABLE 4.20

COMBINED POLICY: PERCENTAGE CHANGE IN DOMESTIC AND EXPORT PRICES

Sector	PD	PE	E
Agriculture	14.23	5.77	-10.42
Crude Oil	18.60	9.81	0.00
Mining and Quarrying	12.32	-5.45	11.91
Petroleum Refining	16.90	-1.58	0.86
Manufacturing	30.80	1.10	-17.40
Utility	12.40	-5.35	0.00
Construction	10.90	-6.64	0.00
Trade	12.90	-4.90	10.68
Transportation	13.50	-4.42	9.56
Finance	12.40	-5.33	11.69
Community Social and Personal Services	13.24	-4.67	0.00

sector had the highest increase of 30.8 percent, whereas the construction sector had the lowest rate of 10.9 percent.

Export Prices

The increase in export subsidies decreased the price of exports, while tariffs and exchange rate devaluation put upward pressure on export prices. Table 4.20 shows that prices of exports decreased in all sectors except those sectors which did not receive a tariff increase (agriculture, manufacturing and oil). The highest export increase was for the oil sector with a rate of 9.8 percent, followed by the agriculture sector with an increase of 5.7 percent, then the manufacturing sector with an increase of 1.58 percent. The small country assumption implies that export will respond inversely to the change in export prices. Table 4.20 shows that exports of the agriculture and manufacturing sectors decreased by 10.42 and 17.40 percent. Although the oil sector experienced the highest increase in price of exports, its export demand did not change. This is due to our assumption of fix oil exports. The rest of the economic sectors experienced an increase in export demand with different rates as seen in table 4.20. The combined policy had a significant effect on the exports of the non-oil sector, which increased by 37 percent.

Imports

Table 4.21, shows that all sectors which received a tariff increase experienced an identical increase in import

TABLE 4.21

COMBINED POLICY: PERCENTAGE CHANGE IN SECTORAL IMPORT

Sector	PM	M
Agriculture	5.90	7.24
Crude Oil	8.00	0.00
Mining and Quarrying	11.17	1.90
Petroleum Refining	13.40	0.00
Manufacturing	5.45	1.90
Utility	13.40	0.00
Construction	13.40	0.00
Trade	13.40	0.00
Transportation	13.40	1.75
Finance	13.40	0.00
Community Social and Personal Services	13.40	0.00

prices of 13.4 percent, which is equivalent to the summation of the changes in both tariff and the exchange rate. Moreover, the agriculture and manufacturing sectors import prices had increased by 5.9 and 5.45 percent respectively.

Although import prices across all sectors increased, this did not decrease all sector imports. Table 4.21 shows that only agriculture, mining, manufacture and trade sectors imports' increased. This reflects the fact that some imported goods cannot be substituted by domestic goods, such as parts and new materials.

Trade balance

The above results show that both exports and imports increased. Exports increased by 0.12 percent and imports by 0.5 percent. But because the base value for export is much greater than import value, the net effect is an increase in the trade surplus by 35 percent. Thus, to restore balance of payments equilibrium, there is a capital outflow, or, a 35 percent decrease in foreign saving.

Resource allocation

The change in all three trade policies affected both commodity and factor prices which in turn affected production and income. Table 4.22 shows that net prices increased in all sectors at a high rate that varies from 12.5 percent in the construction sector to a 53.5 percent in the manufacture sector. This increase in net prices was associated with an increase in nominal wages by an average

TABLE 4.22

COMBINED POLICY: PERCENTAGE CHANGE IN NET PRICES AND REAL WAGE

Sector	PN	W^a/PN
Agriculture	15.60	0.93
Crude Oil	18.60	0.78
Mining and Quarrying	16.67	0.87
Petroleum Refining	19.50	0.74
Manufacturing	53.50	0.27
Utility	14.82	0.98
Construction	12.50	1.16
Trade	13.50	1.07
Transportation	17.00	0.85
Finance	13.42	1.08
Community Social and Personal Services	16.87	0.86

of 14.53 percent. As a result, as table 4.22 shows, all real wages increased. Consequently, labor demand declined across all sectors, except the manufacturing, which experienced an increase in employment of 51.5 percent (table 4.23). This explains the increase in output in this sector by 12.8 percent while the other sectors experienced an output decline by a rate less than 0.5 percent. In aggregate, total output increased by 0.15 percent.

Income

The average nominal wage increase of 14.5 percent increased household income by almost the same rate, 14.1 percent. Government income decreased by 0.15 percent. This can be attributed to the decline in oil production.

Consumption

The increase in household income was followed by an increase in household consumption by the same rate of 14.1 percent. On the other hand, government consumption fell by 1.6 percent.

Investment

Despite the decrease in foreign saving by 35 percent, total investment increased by 12.5 percent. The decline in foreign saving was compensated by an increase in both oil and non-oil saving, as shown in table 4.24.

TABLE 4.23

COMBINED POLICY: PERCENTAGE CHANGE IN SECTORAL OUTPUT AND TOTAL LABOR FORCE

Sector	X	L
Agriculture	-0.42	-7.75
Crude Oil	-0.11	-1.14
Mining and Quarrying	-1.56	-4.83
Petroleum Refining	0.00	-0.23
Manufacturing	12.86	51.50
Utility	-0.14	-3.80
Construction	-0.33	-1.60
Trade	-0.25	-3.86
Transportation	-0.12	-1.60
Finance	-0.37	-3.85
Community Social and Personal Services	-0.23	-1.15

TABLE 4.24

COMBINED POLICY: PERCENTAGE CHANGE IN SOME MACROECONOMIC VARIABLES

Variables	Percentage Change
HI	14.1
GR	-0.15
CH	14.1
CG	-1.60
GDP	15.7
Sf	-35.0

Conclusions and comparisons

In this study we investigated the effects of economic policies that aimed at diversifying the Saudi economy, such as tariffs, exchange devaluation and subsidies. Our analysis focused on the effects of these policies on sectoral output, employment, exports, imports, aggregate household and government incomes, and on the balance of payments.

The Saudi economy is dependent on oil exports, where a slight decline in oil export had a heavy impact on output, exports, trade balance, government income, and consumption. These results suggest that it is beneficial for the Saudi economy to utilize its oil income by investing in other productive sectors such as manufacturing and hydrocarbon industry in order to diversify its economic base before oil is depleted.

Therefore, we applied five different policies to observe their impact on major economic variables. The results suggest that the economic performance under both export promotion and import substitution policies is much better than its performance under free trade policy. Thus, in the remainder of this chapter we analyze the effect of the policy simulations on some economic diversification indicators such as non-oil sector output, exports, income in general and industrial and agricultural output, exports, and employment in particular.

Table 4.25 compares the effect of these different

TABLE 4.25

COMPARISON BETWEEN ALL POLICIES PERCENTAGE CHANGE ON MAIN MACROECONOMIC VARIABLES

Variables	ERP	TMP	EOILP	CPP	FTP
X	0.03	-0.03	-3.0	0.16	0.02
Xnoil	9.0	1.5	-18.0	37.0	0.2
Xm	-3.4	-7.6	10.7	13.0	10.7
TB	4.0	-2.0	-41.0	35.0	2.0
Enoil	2.4	0.2	-5.0	0.90	-0.2
HI	3.0	-0.7	10.0	14.1	0.5
GR	0.8	2.2	-9.5	-0.15	-0.1
CH	3.0	-0.7	10.0	14.1	0.5
CG	0.94	4.0	-9.1	-1.6	-1.7
M	-1.6	-3.0	3.4	2.0	0.8
GDP	3.9	0.7	-10.0	15.7	0.07

where

ERP = isolated policy(1).

TMP = isolated policy(2).

EOILP = isolated policy(4).

CPP = combined policy.

FTP = isolated policy(3).

policies on the above variables, and it shows that combined a policy has a substantial effect on the non-oil sector output which increased by 37 percent, compared to 0.2 percent under free trade policy and a decline of 18 percent under oil export restriction policy. Also, the combined policy proved to be superior in terms of increasing the amount of foreign exchange, where it increased the trade balance by 35 percent, compared to an increase of 2 percent under free trade policy and a decline of 41 percent under export policy. Moreover, in terms of the impact on the industrial sector, the combined policy had the greatest impact with a rate of 13 percent, compared to a 10.7 percent increase under the free trade policy. While currency devaluation and protection policies had a negative impact on the industrial output, they had a positive impact on total non-oil sectorial outputs as can be shown in table 4.25.

The exchange rate devaluation policy had the greatest effect on exports of non-oil sectors. Exports increased by a rate of 2.4 percent, compared to an increase of 0.9 percent under combined package, and 0.2 percent and 0.2 percent under the protection policy. Exports of the non-oil sectors experienced the highest decline of 5 percent under the oil export policy, and 0.2 percent decline under the free trade policy.

In terms of income distribution, all policies show a positive effect, where combined policy increased household income by 14.1 percent while it increased by 3 percent under devaluation policy. Import substitution, or the protection

policy, had a negative impact on household welfare, where the protection policy decreased household consumption and income by 0.7 percent compared to 0.5 percent decline under free trade policy. The import substitution policy showed a better performance in terms of decreasing the economic dependency on imports where imports under this policy declined by 3 percent compared to 1.6 percent decrease under foreign exchange policy.

Finally, table 4.25 shows the superiority of the combined policy on Saudi gross domestic product which increased under this policy by 15.7 percent while the same variables experienced a 10 percent decline under oil export policy.

CHAPTER VI

SUMMARY AND CONCLUSION

The Saudi high dependency on oil exports as a major source of income and exchange earnings resulted in a series of external shocks during the past six years when the price of oil fell below ten dollars per barrel in 1985. This caused the country to experience a severe reduction of foreign exchange on which infrastructural development and production depended. As a result, the growth rate of the economy slowed.

Since then, the Saudi policy makers changed their development strategy by focussing investment on non-oil sectors such as manufacturing and agriculture. Therefore, the fourth and fifth development plans which covered the period of (1985-1990) and (1990-1995) established policies which attempt to diversify the Saudi economic base and reduce dependency on oil as a major source of income. In this regard, the government recently increased the tariff rate on imported goods from 3 percent to 20 percent to protect the domestic "infant" industries.

Although there is no unique definition for the term 'diversification', this term in the Saudi economy is defined as a long term structural change in the non-oil domestic production base in order to reduce dependency on expanding

crude oil, and reduce dependency on imports.

Thus, a (CGE) model was developed to analyze the effects of various trade and incentive policies aimed at diversifying the economic structure of Saudi Arabia, such as tariffs, exchange devaluation, and subsidies. Our analysis focused on the effect of these policies on non-oil output, export, and foreign imports.

The conclusion that can be drawn from this study is that trade policies, particularly, exchange devaluation policy (policy(1)), can be used in Saudi Arabia to increase the export of non-oil sectors, especially the manufacturing and agricultural sectors. Thus, such a policy will help the country to reduce its dependency on oil exports.

Although devaluation has an expansionary effect on aggregate domestic output, it has a contractionary effect on some sectors such as manufacturing, utility and community services sectors. But when devaluation policy was accompanied with an increase in tariffs and subsidy rates, as shown in experiment number 5, manufacturing sector output increased by 13 percent.

Experiment number 2 shows that increasing tariffs resulted in both consumer and producer welfare losses. Because tariffs distort both output and input prices, household consumption decreased by 0.7 percent and aggregate output by 0.03 percent. But on the another hand, increasing tariffs had a positive impact on non-oil output which increased by 1.5 percent. On the import side, tariffs were shown to be effective in reducing imports, where aggregate

imports decreased by 3.0 percent. In terms of exports, the result of this experiment tends to support Milner arguments (1989) that in capital rich LDC's labor intensive non-tradable sectors bear the principle burden of protection where protection promotes exports which are capital intensive. In our case, manufacturing export increased by 13.6 percent.

Table 4.25, which compares the effect of all different experiments, shows that a combined policy has a substantial effect on the non-oil sector output which increased 3.7 percent, compared to 0.2 percent under free trade policy. the combined policy proved to be superior in terms of increasing the amount of foreign exchange, where it increased the trade balance by 35 percent compared to an increase of 2 percent under free trade policy. Moreover, in terms of the impact on the industrial sector, the combined policy had the greatest impact with a rate of 13 percent compared to 10.7 percent increase under the free trade policy. Table 4.25 also shows the superiority of the combined policy with respect to increasing Saudi gross domestic product, which increased under this policy by 15.7 percent compared to 0.07 percent under the free trade policy.

Accordingly, the most significant findings of this study is that trade policy, although perhaps not the best tool for structural change, can be used to reduce the degree of economic dependency on oil. The study also confirms the findings of other studies in the development literature,

that an export promotion strategy is superior to import substitution or protection strategy in terms of non-oil output, non-oil export, GDP, and private income. These findings suggest that it is beneficial for Saudi Arabia to use trade policy, especially those that are pro-export promotion, to diversify its economic base and reduce its dependency on oil.

Despite this, the above results show that distorting policies have a positive effect on some key economic variables like non-oil output, non-oil export, GDP and investment. It does not mean necessarily that these policies are superior to a free trade policy. But rather it means that in a world where protectionist trade practices are exist, no country in isolation can be considered in a free trade position. Thus, we agree that free trade is the first alternative, but since it cannot be achieved under the current world market conditions, trade distortion policies are a second best alternative.

Finally, it would be incorrect to imply that our simulations captured all of the economic adjustments to new trade policies, and that the results show fully all of the costs and benefits of these policies. Our model measures only the static effects of simulation policies. According to our definition of "diversification" as a long term adjustment process, we need a dynamic model that can capture the dynamic changes associated with capital accumulation and population growth. Thus, a dynamic analysis can be done by future researchers if they have access to a better and ample

data.

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APPENDIX A

EQUATIONS OF THE SAUDI (CGE) MODEL

I. Production and Employment

Production functions	Number of Equation
(1) $X_i = A_i [b_1 K_i^{-\sigma_1} + (1 - b_i) L^{a^{-\sigma_1}}]^{-1/\sigma_1}$	n
Labor aggregation function	
(2) $L^a = u_1 L_1^{-\sigma_1} + u_2 L_2^{-\sigma_1} + u_3 L_3^{-\sigma_1}$	n
Labor Demand function	
(3) $W_s = PN_1 (1 - b_1) u_s A_1^{-\sigma_1} (X_1/L_{is})$	3-n
Labor Market Equilibrium	
(4) $\Sigma_s L_s = \Sigma L_{1s}$	3
Net Price Equation	
(5) $PN_1 = PD_1 - td_1 PD_1 - \Sigma_j a_{j1} P_j$	n

II Foreign Trade

Export Demand Functions

(6) $E_{no11} = E_o(\pi_1/PWE_1)^{n1}$	10
(7) $E_{o11} = \bar{E}_{o11}$	1

Number of Equation

Import Demand Functions

(8) $M_i = (PD_i/PM_i)^{ui} \ (\delta_i/1-\delta_i)^{ui} \ D_i$ n

(9) $P_i = 1/\epsilon_i \ [\delta_i^{-ui} PM_i^{1-ui} + (1 - \delta_i)^{ui} . \ PD_i]^{1/1-ui}$ n

Expect Price Equations

(10) $PWE_i = PD_i/ER.(1+te_i)$ n

(11) $PM_i = PW_i \ (1 + tm_i) \ . \ ER$ n

Government Aid Function

(12) $AID = ad.GR$ 1

Balance of Payment Equlbrium

(13) $S_f = \Sigma_i PW_i.M_i.ER - \Sigma_i \ PD_i.E_i/(1+te). \ ER$
$+ AID + NTPI + NCTOUT + REM + DPOUTH$ 1

III Income

Oil Capital Income Equation

(14) $KIO = \Sigma_{j=2,4} v_j.PD_jX_j - \Sigma_s \Sigma_{j=2,4} L_s.W_s$

$- \Sigma_{j=2,4} td_j.PD_j.X_j - g_1.PD_4X_4$ 1

Number of Equation

Non-oil Capital Income Equation

(15) $KINO = \underset{j=2,4}{\Sigma} v_j.PD_jX_j - \Sigma_s\Sigma_{j=2,4} L_s.W_s - \Sigma_{j=2,4} td_j.PD_j.X_j$ 1

$- g_2.PD_jX_j$

Non-oil Capital Income Equation

(16) $KINO = \underset{j=2,4}{\Sigma} v_j.PD_jX_j - \Sigma_s\Sigma_{j=2,4} L_s.W_s - \Sigma_{j=2,4} td_j.PD_j.X_j$ 1

$- g_2.PD_jX_j$

Household Income Equation

(17) $HI = GDP - KIO - KINO - NTPI - GTH - NINX$ 1

Government Income Equation

(18) $GR = \Sigma_j tm_j PW_j ER + t_1 \underset{j=2,4}{\Sigma} PD_j E_j + t_2 KINO + t_3 HI$

$+ \overline{GIEOUT}$ 1

Gross Domestic Product Equation

(19) $GDP = \Sigma_j PD_j X_j - \Sigma_j\Sigma_i a_{ij}(PD_jX_j) + \Sigma_j PW_j tm_j M_j + w_g$ 1

Indirect Tax equation

(20) $NINX = \Sigma_j tm_j M_j PW_j ER - \Sigma_j td_j X_j$ 1

IV Investment

Total Investment Equation

Number of Equation

(21) $T_{inv} = S_{gov} + S_H + S_{oil} + S_{noil} + S_f - CHST$ 1

Government Saving Equation

(22) $S_{gov} = S_g\ GR$ 1

Household Saving Equation

(23) $S_H = S_h\ HI$ 1

Non-oil Saving Equation

(24) $S_{noil} = KINO + GTNOIL - t_2 KINO - NOTOUT$ 1

Oil saving Equation

(25) $S_{oil} = KIO - t_1 . \sum_{j=2,4} E_j - OTOUT$ 1

Sectoral Investment Eqquation

(26) $Inv_i = z_i . TINV$ n

V Consumption

Government Consumption

(27) $CG = GR - W_g - GTNOIL - GTH - S_{gov} GR + \Sigma_j td_j (PD_j\ X_j) - ad.GR$ 1

Household Consumption Equation

(28) $CH = (1 - S_h - t_3) . HI - HTOUT$ 1

Number of Equation

Government Sectoral Consumption Equation

(29) $CG_i = r_i \, CG$ n

Household Sectoral Consumption Equation

(30) $CH_i = Q_i/P_i$ n

VI Product Market Equilibrium

Intermediate Demand Equation

(31) $v_i = \Sigma_j v_{ij}$ n

Domestic Demand Equations

(32) $D_i = d_i V_i + d_i CH_i + d_i CG_i + d_i Z_i$ n

Domestic use ratio function

(33) $d_i = D_i/Q_i = (PQ_i/PD_i)^{ui} \cdot (1 - \delta_i)^{ui} \cdot \epsilon_i^{\mu i - 1}$ n

Total Demand Function

(34) $X_i^d = d_i V_i + d_i CH_i + d_i CG_i + d_i Z_i + E_i$ n

Supply-Demand Balance Equation

(35) $0 = X_i^d - X_i^s$ n

Price Level Equation

(36) $\Sigma_i \, \Omega_i \, P_i = \overline{P}$ 1

List Of Variables And Parameters

Endogenous Variables

Number	Variables	Definition
n	X_i	Sectoral Outputs
n	L_i^a	Aggregate Sectoral Labor
s.n	L_{is}	Sectoral Labor By Category
3	W_s	Wages By Category
n	PN_i	Net Prices
n	M_i	Sectoral Imports
n	E_i	Sectoral Exports
n	P_i	Composite Good Prices
n	PD_i	Domestic Prices
n	PM_i	Import Prices
n	PWE_i	Export Prices In Foreign Currency
1	S_f	Foreign Capital Flow
1	KIO	Oil Capital Income
1	KINO	Non-Oil Capital Income
1	HI	Household Income
1	GR	Government Revenue
1	GDP	Gross Domestic Product
1	AID	Government Aid To Other Country
1	NINX	Indirect Taxes
1	TINN	Total Investment
n	INV_i	Sectoral Investment
1	S_{gov}	Government Savings
1	S_H	Household Savings
1	S_{oil}	Oil Savings

1	S_{noil}	Non-Oil Savings
1	CH	Household Consumption
1	CG	Government Consumption
n	CH_i	Household Sectoral Consumption
n	CG_i	Government Sectoral Consumption
n	V_i	Intermediate Demand
n	D_i	Domestic Demand
n	d_i	Domestic Use Ratio
n	X_i	Aggregate Domestic Demand
16n+3n+18		

Exogenous Variables

$\bar{K}_i$	Sectoral Capital stock
$\bar{L}_i^a$	Total Labor of categories
$\bar{\pi}_i$	Average world price of export in foreign currency
$\overline{PW}_i$	Average world price of imports in foreign currency
$\overline{ER}$	Exchange rate
$\overline{NTPI}$	Net property and entrepreneurial
$\overline{NCTOUT}$	Net current transfer out of the country
$\overline{DPOUTH}$	Direct purchase abroad by the resident household
$\overline{REM}$	Foreign labor remittances
$\overline{GTH}$	Government transfer to households
$\overline{W_g}$	Government employees wage payments
$\overline{GIEOUT}$	Government interest earning
$\overline{CHST}$	Change in stock

$\overline{\text{OTOUT}}$	Oil transfer to the rest of the world
$\overline{\text{GTNOIL}}$	Government transfer to the non-oil sectors
$\overline{\text{NTOUT}}$	Non-oil transfers to the rest of the world
$\overline{\text{HTOUT}}$	Household transfers to the rest of the world

Parameters

A_i	Technological or shift parameter
b_i	Capital share
σ_i	Elasticity of substitution between labor and capital
u_1, u_2, u_3	Labor share of different categories
ϵ_i, δ_i	Parameters for CES trade aggregation function
μ_i	Trade elasticity of substitution
te_i	Export subsidy rate
tm_i	Import tariff rate
n_i	Price elasticity of export demand
v_j	Base year unit value added
Z_i	Sectoral investment allocation shares
r_i	Government expenditures shares
Q_i	Household expenditures shares
t_1	Tax rate on oil exports
t_2	Tax rate on non-oil capital income
t_3	Tax rate on household income
g_1, g_2	Adjustment parameters
sg	Government saving rate
sh	Household saving rate
Ω_i	Weights in the price level equation

APPENDIX B

BASE YEAR DATA

TABLE I

ESTIMATED COST PRODUCTION FUNCTION PARAMETERS

Sector	A_i	b_i	σ_i
Agriculture	1.301953408	0.9119000000	1.2
Crude Oil	1.681561768	0.8107000000	1.2
Mining and Quarrying	5.379616182	0.7480000000	1.2
Petroleum Refining	1.947889652	0.7982000000	1.2
Manufacturing	1.908070376	0.7988000000	1.2
Utility	4.128389183	0.7444000000	0.7
Construction	3.197602902	0.8326999999	0.7
Trade	1.084468459	0.8465000002	0.7
Transportation	4.246123026	0.7587000000	0.7
Finance	1.690902835	0.8967999970	0.7
Community Social and Personal Services	0.8136508029	0.4071000000	0.7

Source : Appendix E

TABLE II

INPUT OUTPUT TABLE FOR SAUDI ARABIA (1981)
COEFFICIENTS MATRIX

	Agricul-ture	Crude Oil	Mining and Quarrying	Petroleum Refining	Manufac-turing	Utility	Construction	Trade	Transport-tation	Finance	Community Social and Personal Services
Agriculture	0.0241345	0.0000000	0 0000000	0.0000000	0.0000389	0 0000000	0.0000238	0 0000000	0.0000000	0 0000000	0.0000000
Crude Oil	0 0815998	0.0010057	0 0044281	0 0341352	0.0059168	0 1128670	0 0153574	0 0092209	0.0792235	0.0287474	0.0542096
Mining and Quarrying	0 0000000	0 0000685	0.0685999	0.0023279	0 0017925	0 0014588	0.0356707	0 0001598	0 0001607	0.0005910	0.0003055
Petroleum Refining	0 0036884	0.0000454	0 0002123	0.0015430	0.0002655	0 0051119	0.0006940	0 0004155	0.0035773	0.0012970	0.0024456
Manufacturing	0.1390774	0.0041576	0 3123451	0.1410850	0 3420220	0 3890531	0.2635408	0 0704223	0.2507615	0 1280664	0.2755222
Utility	0.0000000	0 0000189	0 0022817	0 0006399	0 0007577	0 0019325	0.0007715	0 0012430	0 0010973	0 0031229	0.0025862
Construction	0 0000000	0.0000049	0 0000265	0.0001620	0.0005699	0.0008104	0 0024892	0 0001576	0 0077033	0 0025083	0.0003467
Trade	0.0305338	0 0007732	0.0746040	0 0262673	0.0639149	0.0737922	0.0577446	0.0142662	0 0477622	0.0244876	0.0516731
Transportation	0.0288741	0 0012767	0.0825634	0 0433177	0.0680270	0.1239137	0.0647445	0 0617928	0.0862316	0.0584246	0.0594878
Finance	0 0070817	0.0005135	0.0045634	0.0174270	0.0161957	0.0412069	0 0543030	0.0540101	0.0459261	0.0832381	0.0369655
Community Social and Personal Services	0.0000000	0 0000890	0 0003714	0.0030172	0.0004986	0.0011845	0.0047659	0.0047659	0 0008562	0.0006753	0.0007028

TABLE III

ESTIMATED LABOR AGGREGATION PARAMETERS

Sector	u_{i1}	u_{i2}	u_{i3}
Agriculture	0.2148121334	0.4146041768	0.3705836898
Crude Oil	0.3557074933	0.6059995979	0.03829290885
Mining and Quarrying	0.2987182468	0.6775619719	0.02371978132
Petroleum Refining	0.3557508300	0.6059742108	0.03827495923
Manufacturing	0.1885207130	0.7903261418	0.02115314518
Utility	0.1610784324	0.8278542256	0.01106734200
Construction	0.08029224440	0.9110610810	0.008646674567
Trade	0.05414537198	0.8899318550	0.05592277304
Transportation	0.1858675834	0.7866309945	0.02750142205
Finance	0.3747945649	0.6063960565	0,01880937857
Community Social and Personal Services	0.3607785433	0.5075156076	0.1317058491

Source : Appendix E

TABLE IV

SECTORAL CAPITAL STOCK (1981)
(MILLION OF SR)

Sector	$\bar{K}_1$
Agriculture	3988.5
Crude Oil	337631.2
Mining and Quarrying	339.2
Petroleum Refining	16586.3
Manufacturing	4228.1
Utility	218.9
Construction	24401.2
Trade	20379.7
Transportation	5409.0
Finance	16404.6
Community Social and Personal Services	2636.0

Source : National Accounts of Saudi Arabia (1982), pp. 42-43.

TABLE V

TOTAL SECTORAL BY OCCUPATION LABOR FORCE
IN SAUDI ARABIA (1981)

Sector	L_1	L_2	L_3	Total
Agriculture	33,785	192,809	355.911	582.504
Crude Oil	4,614	22,670	1,742	29,026
Mining and Quarrying	1,038	7,190	272	8,500
Petroleum Refining	1,426	7,005	538	8,969
Manufacturing	7,034	101,817	2,791	111,642
Utility	5,233	28,691	2,165	36,089
Construction	33,858	323,163	19,186	376,207
Trade	22,143	273,930	61,072	357,145
Transportation	37,497	179,452	26,540	243,490
Finance	11,224	27,402	3,727	42,353
Community Social and Personal Services	123,281	272,900	164,189	560,371

Source : Al-Khouli (1985), pp. 371

TABLE VI

DOMESTIC SECTORAL OUTPUT (1981)

Sector	X_1
Agriculture	8,133.5
Crude Oil	343,730.9
Mining and Quarrying	3,769.1
Petroleum Refining	24,691.1
Manufacturing	15,442.4
Utility	1,604.1
Construction	100,716.4
Trade	27,197
Transportation	36,088.4
Finance	27,987.2
Community Social and Personal Services	10,672.1

Source : National Accounts of Saudi Arabia (1982) pp. 54.

TABLE VII

SECTORAL INTERMEDIATE DEMAND (1981)

Sector	V_1
Agriculture	0.68501
Crude Oil	0.99205
Mining and Quarrying	0.45000
Petroleum Refining	0.73008
Manufacturing	0.50000
Utility	0.24867
Construction	0.49989
Trade	0.78746
Transportation	0.47443
Finance	0.66884
Community Social and Personal Services	0.51576

Source : Tawi, S. pp. 170

TABLE VIII

SECTORAL PRICES (1981)

Sector	PD_i	P_i	PM_i	$\overline{PW}_i$	$\overline{ER}$
Agriculture	1.0	1.0	1.0	1.0	1.0
Crude Oil	1.0	1.0	1.0	1.0	1.0
Mining and Quarrying	1.0	1.0	1.0	1.0	1.0
Petroleum Refining	1.0	1.0	1.0	1.0	1.0
Manufacturing	1.0	1.0	1.0	1.0	1.0
Utility	1.0	1.0	1.0	1.0	1.0
Construction	1.0	1.0	1.0	1.0	1.0
Trade	1.0	1.0	1.0	1.0	1.0
Transportation	1.0	1.0	1.0	1.0	1.0
Finance	1.0	1.0	1.0	1.0	1.0
Community Social and Personal Services	1.0	1.0	1.0	1.0	1.0

TABLE X

TARIFF, EXPORT SUBSIDY, AND INDIRECT TAX RATES (1981)

Sector	tm_i	te_i	td_i
Agriculture	0.01990	0.0	-0.06942
Crude Oil	0.0	0.0	0.0
Mining and Quarrying	0.02004	0.0	0.0
Petroleum Refining	0.0	0.0	0.00018
Manufacturing	0.02406	0.0	0.0
Utility	0.0	0.0	-0.51848
Construction	0.0	0.0	-0.10746
Trade	0.0	0.0	-0.02037
Transportation	0.0	0.0	0.00184
Finance	0.0	0.0	0.0
Community Social and Personal Services	0.0	0.0	0.0

Source : Tawi, S. pp. 167.

TABLE XI

PARAMETERS FOR IMPORT AND COMPOSITE PRICE FUNCTIONS (in SR) (1981)

Sector	u_i	δ_i	ϵ_i
Agriculture	2.5	0.653607	0.548201
Crude Oil	0.5	0.0	1.0
Mining and Quarrying	2.5	0.322563	0.574179
Petroleum Refining	0.5	0.0	0.1
Manufacturing	2.5	0.964265	0.919210
Utility	0.5	0.0	1.0
Construction	0.5	0.0	1.0
Trade	0.5	0.0	1.0
Transportation	2.5	0.386821	0.531498
Finance	0.5	0.0	1.0
Community Social and Personal Services	0.5	0.0	1.0

TABLE XII

FINAL DEMAND BUDGET SHARES (in SR)
(1981)

Sector	r_i	Q_i	Z_i
Agriculture	0.00016	0.10131	0.0
Crude Oil	0.0	0.0	0.0
Mining and Quarrying	0.0	0.0	0.0
Petroleum Refining	0.00474	0.03824	0.0
Manufacturing	0.00806	0.38307	0.14182
Utility	0.00301	0.00988	0.0
Construction	0.27473	0.0	0.80662
Trade	0.00692	0.10434	0.02578
Transportation	0.02148	0.12159	0.02578
Finance	0.04611	0.11092	0.0
Community Social and Personal Services	0.01302	0.08109	0.0

Source : Tawi, S. pp. 170.

TABLE XIII

PARAMETERS FOR EXPORT AND IMPORT DEMAND (in SR)
(1981)

Sector	n_i	π_i	E_i
Agriculture	2.0	1.0	90.2
Crude Oil	0.0	1.0	335543.2
Mining and Quarrying	2.0	1.0	5.8
Petroleum Refining	0.5	1.0	19680.7
Manufacturing	2.0	1.0	1016.2
Utility	0.0	1.0	0.0
Construction	0.0	1.0	0.0
Trade	0.0	1.0	249
Transportation	2.0	1.0	3787.9
Finance	2.0	1.0	487.7
Community Social and Personal Services	0.0	1.0	0.0

TABLE XIV

BASE YEAR MACROECONOMIC VARIABLES (in SR)
(1981)

Variable	Million of SR
GDP	520,588.8
Income	
(HI)	118,015.2
(GR)	337,702.6
Consumption	
household (CH)	114,905.1
government (CG)	52,008.9
Investment (TINV)	106,375.9
Foreign Saving (S^f)	151,863.8

Source : National Accounts of Saudi Arabia (1982)

TABLE XV

OTHER PARAMETERS

Parameter	Rate
ad	0.095739471
t_1	0.8740864
t_2	0.5172100
t_3	0.0036300
S_g	0.6271500
S_h	0.0226500
g_1	0.1095560
g_2	0.1363810

Source : National Accounts of Saudi Arabia (1982).

TABLE XVI

OTHER EXOGONEOUS VARIABLES (1981)

Variables	Million of SR
$\overline{NTPI}$	7986.4
$\overline{NCTOUT}$	46939.8
$\overline{DPOUTH}$	5693.1
$\overline{REM}$	4175.3
$\overline{GTH}$	4929.1
$\overline{Wg}$	29905.7
$\overline{GIEOUT}$	232.2
$\overline{CHST}$	6427.5
$\overline{OTOUT}$	9890.0
$\overline{GTNOIL}$	1656.6
$\overline{NTOUT}$	4936.0
$\overline{HTOUT}$	9.0

APPENDIX C

MATHEMATICAL DERIVIATIONS

The labor demand function is derived as follows. From chapter III the labor demand equation is :

$$PN_i = \frac{dX_i}{dL_s} = ws \qquad \text{(C-1)}$$

where the production function is :

$$X_1 = A_1 \left[b_1 . K_1^{-\sigma_1} + (1-b_1) \left[u_1 L_1^{-\sigma_1} + u_2 L_2^{-\sigma_1} + u_3 L_3^{-\sigma_1}\right]^{-1/\sigma_1}\right. \qquad \text{(C-2)}$$

$$\frac{dX_1}{dL_1} = A_i^{-\sigma_1} (1 - b_1) u_1 \, (X_1/L_1)^{1+\sigma_1} \qquad \text{(C-3)}$$

$$\frac{dX_1}{dL_2} = A_1^{-\sigma_1} (1 - b_1) u_1 \, (X_1/L_2)^{1+\sigma_1} \qquad \text{(C-4)}$$

$$\frac{dX_1}{dL_3} = A_1^{-\sigma_1} (1 - b_1) u_1 \, (X_1/L_3)^{1+\sigma_1} \qquad \text{(C-5)}$$

Let $A_1^{-\sigma_1} (1 - b_1) . u_1 = R_{11}$ (C-6)

Let $A_1^{-\sigma_1} (1 - b_1) . u_2 = R_{21}$ (C-7)

Let $A_1^{-\sigma i} (1 - b_1) . u3_3 = R_{31}$ (C-8)

By substituting the value of R_{11}, R_{21}, R_{31} from (C-6), (C-7) and (C-8) into equation (C-2), (C-3), and (C-4)

$$\frac{dX_1}{dL_{11}} = R_{11} . (X_1/L_{11}) \qquad \text{(C-9)}$$

$$\frac{dX_1}{dL_{21}} = R_{21} . (X_1/L_{21}) \qquad \text{(C-10)}$$

$$\frac{dX_1}{dL_{31}} = R_{31} \cdot (X_i/L_{31}) \qquad \text{(C-11)}$$

Finally, by substituting the values of (dX_1/dL_{s1}) from (C-9), (C-10),(C-11) into (C-1) we get

$$W_1 = PN_1 \ (1 - b_1) \ u_1 \ A^{-\sigma 1} \ (X_1/L_{11})^{1+\sigma 1} \qquad \text{(C-12)}$$

$$W_2 = PN_1 \ (1 - b_1) \ u_2 \ A^{-\sigma 1} \ (X_1/L_{12})^{1+\sigma 1} \qquad \text{(C-13)}$$

$$W_3 = PN_1 \ (1 - b_1) \ u_3 \ A^{-\sigma 1} \ (X_1/L_{13})^{1+\sigma i} \qquad \text{(C-14)}$$

APPENDIX D

ESTIMATED DATA AND PARAMETERS

Data for production function

Most of the data that is needed for the (CES) production function such as elasticities of substitution between labor and capital, capital share, labor shares and technology parameters are not available. Therefore we need to estimate all these parameters as follows:

Step 1 - From Appendix C we have the following equations :

$$R_{1i} = (w_1/PN_1).(L_1/X)^{(1-\sigma_1)} \quad \text{(D-1)}$$

$$R_{2i} = (w_2/PN_1).(L_2/X)^{(1-\sigma_1)} \quad \text{(D-2)}$$

$$R_{3i} = (w_3/PN_1).(L_3/X)^{(1-\sigma_1)} \quad \text{(D-3)}$$

where σ_1 = Factors elasticity of substitution.

w_1, w_2, w_3 = Labor wage rates.

L_1, L_2, L_3 = The total labor force of different skill

X = Total output

Since (σ_1) is unknown, we will follow some studies such as Lawrence White's (1987) that assume that the elasticity of substitution in LDC's tends to clump between 0.5 and 1.2. Thus the gross values of (σ_1) are shown in table (D-1). Given the base year values for L_1, L_2, L_3, w_1, w_2, w_3, and X_1, we can solve for R_{1i}, R_{2i}, R_{3i} as seen in table (D-1).

Step 2 - the solution values of u_1, u_2, u_3 which are defined as the different skills labor share. The results of the first step can be used to solve for u_1, u_2, u_3 as follows :

TABLE D-1

ESTIMATED VALUES OF δ_1 AND ϵ_1 (1981)

Sector	σ_1	R_{1i}	R_{2i}	R_{3i}
Agriculture	1.2	0.2437178122	0.4703943921	0.4204503940
Crude Oil	1.2	0.001557042279	0.002652648630	0.0001676199664
Mining and Quarrying	1.2	0.04257090907	0.09656065340	0.003380351432
Petroleum Refining	1.2	0.007139890314	0.01216185328	0.0007681753285
Manufacturing	1.2	0.05827734727	0.2443132656	0.006539064954
Utility	0.7	0.3964977375	2.037779499	0.02724248055
Construction	0.7	0.02364760435	0.2683249440	0.002546611327
Trade	0.7	0.04503372367	0.7401730522	0.04651202154
Transportation	0.7	0.1197853881	0.5069571425	0.001772373888
Finance	0.7	0.02280703702	1.03690047456	0.001144590219
Community Social and Personal Services	0.7	3.587009216	5.045929684	1.309473923

$$u_{i1} = R_{1i}/R_{1i} + R_{2i} + R_{3i} \quad \text{(D-4)}$$

$$u_{i2} = R_{2i}/R_{1i} + R_{2i} + R_{3i} \quad \text{(D-5)}$$

$$u_{i3} = R_{3i}/R_{1i} + R_{2i} + R_{3i} \quad \text{(D-6)}$$

The result of this step can be seen in table (D-2).

Step-3 - Given the result of steps (1) and (2), the base year values for $\bar{X_i}$, K_i and the guess value for σ_i then we can solve the following system of equation for b_i and A_i as follows :

$$PN_i = A_i\ (1-b_i)u_1(X_i/L_1)^{1+\sigma_1}.w_1 \quad \text{(D-7)}$$

$$X_i = A_i\ [\ b_i\ K_i^{-\sigma_1} + (1 - b_i)(u_1L_1^{-\sigma_1} + u_2L_2^{-\sigma_1} + u_3L_3^{-\sigma_i}\ )\ ]^{-1/\sigma_1} \quad \text{(D-8)}$$

By solving these equations with two unknowns, we can get the estimated values for b_i, A_i, as it is shown in Table (D-3).

TABLE (D-2)

ESTIMATED VALUES OF LABOR SHARES u_{si}

Sector	u_{1i}	u_{2i}	u_{3i}
Agriculture	0.2148121334	0.4146041768	0.3705836898
Crude Oil	0.3557074933	0.6059995979	0.03829290885
Mining & Quarrying	0.2987182468	0.6775619719	0.02371978132
Petroleum Refining	0.3557508300	0.6059742108	0.03827495923
Manufacturing	0.1885207130	0.7903261418	0.02115314518
Utility	0.1610784324	0.8278542256	0.01106734200
Construction	0.08029224440	0.9110610810	0.008646674567
Trade	0.05414537198	0.8899318550	0.05592277304
Transportation	0.1858675834	0.7866309945	0.02750142205
Finance	0.3747945649	0.6063960565	0,01880937857
Community Social & Personal Services	0.3607785433	0.5075156076	0.1317058491

TABLE (D-3)

ESTIMATED VALUES of A_i and b_i

Sector	A_i	b_i	σ_i
Agriculture	1.301953408	0.9119000000	1.2
Crude Oil	1.681561768	0.8107000000	1.2
Mining and Quarrying	5.379616182	0.7480000000	1.2
Petroleum Refining	1.947889652	0.7982000000	1.2
Manufacturing	1.908070376	0.7988000000	1.2
Utility	4.128389183	0.7444000000	0.7
Construction	3.197602902	0.8326999999	0.7
Trade	1.084468459	0.8465000002	0.7
Transportation	4.246123026	0.7587000000	0.7
Finance	1.690902835	0.8967999970	0.7
Community Social and Personal Services	0.8136508029	0.4071000000	0.7

APPENDIX E

GAUSS COMPUTER PROGRAM

```
/*============================================================

            A CGE model for Saudi Arabia on the 1981
                    input/output table
            it is solved using Gauss 386vm

============================================================*/

/*------------------------------------------------------------*/

/* STEP 1: specify kx1 vector of starting values--there MUST
be the same

           number of starting values as there are equation.

============================================================*/


library nlsys.lib;


/*-------------load and set parameter values-------------*/

load X0[139,1] = a:XO;
load te[11,1] = a:te;
load Eo[11,1] = a:Eo;
load tm[11,1] = a:tm;
load A[11,11] = a:A;
load TD[11,1] = a:TD;
load v[11,1] = a:v;
load k[11,1] = a:k;
load DELTA[11,1] = a:DELTA;
load SIGMA[11,1] = a:SIGMA;
load SIGMA1[11,1] = a:SIGMA1;
load b1[11,1] = a:b1;
load b2[11,1] = a:b2;
load b3[11,1] = a:b3;
load u1[11,1] = a:u1;
load u2[11,1] = a:u2;
load u3[11,1] = a:u3;
load bk[11,1] = a:bk;
load cones1[11,1] = a:cones1;
load n[11,1] = a:n;
load mu[11,1]=a:mu;
load phi[11,1]=a:phi;
load q[11,1]=a:q;
load q1[11,1]=a:q1;
load theta[11,1]=a:theta;
load theta1[11,1]=a:theta1;
load epsilon[11,1]=a:epsilon;
load inref[11,1] = a:inref;
load inoil[11,1] = a:inoil;
load exoil[11,1] = a:exoil;
load Zi[11,1] = a:Zi;
load l1[11,1] = a:l1;

load l2[11,1] = a:l2;
load l3[11,1] = a:l3;
```

```
load PN[11,1] = a:PN;
load E[11,1] = a:E;



" the matrices loaded "


te;
Eo;
tm;
A;
TD;
q1;
v;
k;
DELTA;
SIGMA;
SIGMA1;
b1;
b2;
b3;
u1;
u2;
u3;
bk;
cones1;
n;
mu;
phi;
q;
q1;
theta;
theta1;
INREF;
INOIL;
EXOIL;
zi;
E;



/*----------values for exogenous variables 1981----------*/


let ER = 1.0;
let CHST =6427.4;
let LT1 = 281133;
let LT2 = 1437851;
let LT3 = 638362;
let adj1=0.2585662741;
let adj2=0.1207241724;
let RWg=29905.7;
let GTRO=1656.6;
let GTRNO=4936;
let sg = 0.6271479;
```

```
let sp = 0.02265;
let t1=0.8740864;
let t2=0.51721;
let t3=0.00363;
let GIEOUT=232.2;
let OTOUT=9890;
let GTNOIL=1656.6;
let NOTOUT=4936;
let Soil=31126.0;
let Snoil=19078.5;
let Sgov=211789.5;
let Sh=2673.1;
let Sf=-151863.8;
let NCTOUT= 46939.8;
let DPOUTH=5693.1;
let TINV=106375.9;
let CG=52008.9;
let CH=114905.1;
let HTOUT=9.0;
let Wg=29905.7;
let GTH=4929.1;
let REM=4175.3;
let NTPI=7986.4;
let ad = 0.95739471;
 P = ones(11,1);
 PD = ones(11,1);
 PWE = ones(11,1);
 II = ones(11,1);
 PW = ones(11,1);


VF = zeros(rows(X0),1); /*size of this vector is determined
                          from xo */


proc(1) =f(X);
```

```
/*-------------------------------------------------------*/

/*STEP 2: specify the equations to be solved, as a function
of the arguments.

          The objective is to solve for values such that
```

```
f(x) = 0

==========================================================*/


Local  O ,  L1 ,  L2 ,  L3 , PN ,  W1 ,  W2 ,  W3 ,  PM ,
PWE,  E , M , P , KIO ,  KINO  , GDP , GR , INDTX , HI ,
Soil , Snoil , Sgov, Sh , Sf , TINV , CH , CG , PD ,Pl ;


      O=X[1:11,1];
      L1=X[12:22,1];
      L2=X[23:33,1];
      L3=X[34:44,1];
      PN=X[45:55,1];
      W1=X[56,1];
      W2=X[57,1];
      W3=X[58,1];
      PM=X[59:69,1];
      PWE=X[70:80,1];
      E=X[81:91,1];
      KIO=X[114,1];
      KINO=X[115,1];
      GDP =X[116,1];
      GR  =X[117,1];
      INDTX=X[118,1];
      HI  =X[119,1];
      Soil=X[120,1];
      Snoil=X[121,1];
      Sgov=X[122,1];
      Sh  =X[123,1];
      Sf=X[124.1];
      TINV=X[125,1];
      CH  =X[126,1];
      Cg  =X[127,1];
      M =X[92:102,1];
      P=X[103:113,1];
      PD=X[128:138,1];
      Pl = X[139,1];

/*------------------oil capital income--------------------*/


VF[114,1] = KIO -v'*(INOIL.*(PD.*O))+INOIL'*((L1.*W1)
           +(L2.*W2)+(L3.*W3))
           +INOIL'*( TD.*(PD.*O))+ADJ1*(INREF'*(PD.*O));


/*------------------non-oil capital income----------------*/


VF[115,1] = KINO -v'*(exoil.*(PD.*O))+exoil'*((L1.*W1)
           +(L2.*W2)+(L3.*W3))
           +exoil'*(TD.*(PD.*O))+ADJ2*(exoil'*(PD.*O));
```

```
/*-----------------gross domestic product-----------------*/

VF[116,1]=GDP-ones(1,11)*(PD.*O)+(ones(1,11)*A)*(PD.*O)-RWg-
          PW'(tm.*M);

/*------------------goverment income--------------------*/

VF[117,1]=GR-t1*(inoil'*E)-t2*KINO-t3*HI-(PW'*(tm.*M))*ER-GI
          EOUT;

/*-------------------indirect taxes----------------------*/

VF[118,1] =INDTX-(PW'*(tm.*M))*ER-(td'*(PD.*O));

/*-----------------household income----------------------*/

VF[119,1] =HI- GDP+REM+KIO+KINO+NTPI+INDTX-GTH;

/*----------------------oil saving-----------------------*/

VF[120,1] =Soil-KIO +t1*(INOIL'*E)+OTOUT;

/*--------------------non-oil saving--------------------*/

VF[121,1] =Snoil-KINO -GTNOIL+t2*KINO+NOTOUT;

/*----------------government saving---------------------*/

Vf[122,1] =Sgov - Sg*GR;

/*------------------household saving--------------------*/

VF[123,1] =Sh - Sp*HI;

/*--------------foreign capital inflow-----------------*/
```

```
VF[124,1]=Sf+ones(1,11)*((PD.*(1./(1+te))).*(E))-((PW).*ER)'
*M-(NTPI)-(NCTOUT)-(REM)-(DPOUTH)-(ad*GR);

/*-----------------total investment----------------------*/

VF[125,1] =TINV-Soil-Snoil-Sgov-Sh-Sf+CHST;

/*-----------------household consumption-----------------*/


VF[126,1] =CH- (1-Sp-t3).*HI+HTOUT;

/*---------------government consumption-----------------*/


VF[127,1] =CG-GR+Wg+GTNOIL+GTH+Sg*GR-td'*(PD.*O)+(ad*GR);


/*----------------import demand functions----------------*/

VF[92:102,1]=M-((delta.^SIGMA1).*(P./PM).^SIGMA1).*(mu.*(TIN
V/(mu'*P))+phi.*(CHST/(phi'*P))+q.*(CH/(q1'*P))+theta.*(CG/(
theta1'*P))+A*O);

/*--------------------composite prices-------------------*/

VF[103:113,1]=P-epsilon.*((delta.^sigma1).*(PM).^(1-sigma1)+
       ((1-delta).^sigma1)*PD.^(1-sigma1)).^(1./(1-sigma1));

/*--------------product market equilibrium---------------*/

VF[128:138,1]=O-(1./PD).*(MU.*TINV+phi.*CHST+q.*CH+theta.*CG
              +A*(P.*O))-E+(1./PD).*((PW.*(1+tm).*ER).*M);


/*-----------------price level equation------------------*/

VF[139,1]= Pl - (O./(ONES(1,11)*O))'*P;

/*------import prices expressed in domestic currency------*/
```

```
VF[59:69,1] = PM -PW.*(1+tm).*ER;

/*------export prices expressed in domestic currency------*/

VF[70:80,1] = PWE -PD.*(1./((1+te).*ER));

/*-----------------export demand functions---------------*/

VF[81:91,1] = E -Eo.*(II./PWE).^n;

/*-----------------production function------------------*/

VF[1:11,1] =O - cones1.*(bk.*k.^sigma + (1-bk).*(
            u1.*l1.^sigma+u2.*l2.^sigma + u3.*l3.^sigma))
            .^(1./sigma);

/*---------------labor market equilibrium----------------*/

VF[12:22,1]=PN.*b1.*O.^(1-sigma)-L1.^(1-sigma).*ONES(11,1).*
(W1);

VF[23:33,1]=PN.*b2.*O.^(1-sigma)-L2.^(1-sigma).*ONES(11,1).*
(W2);

VF[34:44,1]=PN.*b3.*O.^(1-sigma)-L3.^(1-sigma).*ONES(11,1).*
(W3);

VF[56,1] =ones(1,11)*(L1)-LT1;

VF[57,1] =ones(1,11)*(L2)-LT2;

VF[58,1] =ones(1,11)*(L3)-LT3;

/*----------------------net prices----------------------*/

VF[45:55,1]=PN-(PD-TD.*PD-A'P);


retp(VF);
endp;

/*------------------------------------------------------*/

output file = n1.out reset;
```

```
x1 = nlsys(x0,&f);


vecnames = { O1  ,O2  ,O3  ,O4  ,O5  ,O6  ,O7  ,O8  ,O9
,O10  ,O11 ,L1  ,L2  ,L3  ,L4  ,L5  ,L6  ,L7  ,L8  ,L9  ,L10
,L11 ,L12 ,L13 ,L14 ,L15 ,L16 ,L17 ,L18 ,L19 ,L20 ,L21 ,L22,
L23 ,L24 ,L25 ,L26 ,L27 ,L28 ,L29 ,L30 ,L31 ,L32  ,L33, PN1
,PN2 ,PN3 ,PN4 ,PN5 ,PN6 ,PN7 ,PN8 ,PN9 ,PN10 ,PN11, W1 ,W2
,W3,  PM1 ,PM2 ,PM3 ,PM4 ,PM5 ,PM6 ,PM7 ,PM8 ,PM9 ,PM10
,PM11, PE1 ,PE2 ,PE3 ,PE4 ,PE5 ,PE6 ,PE7 ,PE8 ,PE9 ,PE10 ,
PE11, E1  ,E2  ,E3  ,E4  ,E5  ,E6  ,E7  ,E8  ,E9  ,E10 ,E11,
M1  ,M2  ,M3  ,M4  ,M5  ,M6  ,M7  ,M8  ,M9  ,M10  ,M11, P1
,P2  ,P3  ,P4  ,P5  ,P6  ,P7  ,P8  ,P9  ,P10  ,P11, KIO ,
KINO  , GDP  , GR , INDTX , HI , SOIL , SNOIL , SGOV , SH ,
SF , TINV , CH , CG ,PD1 ,PD2 ,PD3 ,PD4 ,PD5 ,PD6 ,PD7 ,PD8
,PD9 ,PD10 ,PD11, Pl };

nldisp(x0,x1,&f,vecnames);
x11 = x1;
t2 = hsec;
format /rd 1,2;
print "Elapsed time: " (t2-t1) " minutes";
print;
print "solution for 1981";


/*=======================================================*/
```

VITA

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