MANPOWER PROJECTION MODEL FOR ECONOMIC PLANNING IN SAUDI ARABIA USING THE INPUT-OUTPUT TECHNIQUE

By

MOHAMMED SADIK ABDULLAH ALJIFFRY

Bachelor of Industrial Engineering
and Management
Oklahoma State University
Stillwater, Oklahoma
1977

Master of Science
Oklahoma State University
Stillwater, Oklahoma
1978

Submitted to the Faculty of the Graduate College
of the Oklahoma State University
in partial fulfillment of the requirements
for the Degree of
DOCTOR OF PHILOSOPHY
DECEMBER, 1983

MANPOWER PROJECTION MODEL FOR ECONOMIC

PLANNING IN SAUDI ARABIA USING

THE INPUT-OUTPUT TECHNIQUE

Thesis Approved:

M. Palmer Terrell
Thesis Adviser

Earl J. Ferguson

Dean F. Schreiner

Wayne Thomas

Norman N. Durham
Dean of the Graduate College

ACKNOWLEDGMENTS

I am happy to acknowledge here, with thanks and gratitude, the members of my advisory committee. First, I wish to express my heartfelt thanks to my major adviser, Professor Marvin Palmer Terrell, for his direction, encouragement, and assistance throughout my study at Oklahoma State University.

To Professor Dean F. Schreiner goes my deep appreciation for his valuable suggestions, perceptive comments, and the generous time he devoted to me.

To Professor Hamid K. Eldin goes my sincere thanks and appreciations for his counseling and encouragement during my study at this great institution.

To Professors Earl D. Ferguson and Wayne C. Turner go my special thanks and appreciations for their interest and willingness to be on my committee.

I would like also to acknowledge Dr. Saleh H. Humaidan, Director General, Technical Department, the Saudi Fund for Development, for his hospitality while I was in Riyadh collecting data and for his help in introducing me to the staff of the Ministry of Planning (MOP). My thanks and appreciations go to Dr. Hashim M. Al-Ali, Senior Economic Adviser in National Planning, and the rest of the staff of the MOP for their complete cooperation in providing me with the information needed from the MOP.

I am greatly indebted to the Saudi Arabian Government represented

by the Ministry of Education, the Ministry of Higher Education, and the University of King Abdulaziz for the scholarships they awarded me throughout my study in the United States.

Thanks are due to Debra Ann Flint Shores for her understanding and cooperation in editing this text. Thanks also to Top Services Unlimited for word processing services of this text.

Last, but not least, I wish to express my deepest gratitude and appreciation to my family: my mother for her patience, understanding, encouragement, and prayers; my father who in spite of his physical absence, has been my inspiration; my wife, Huda, and my daughter, Alaa, for their patience and understanding; and the rest of my family for their love and continual encouragement.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

Manpower planning must be an ancient art since manpower problems have existed for centuries. Consider the construction of the Great Wall of China and the Great Pyramids of Egypt. Those projects must have required a sizeable number of engineers, architects, and foremen, as well as support workers. Some systems for projecting the required number of workers with a specific type of occupation must have existed. Modern societies are still faced with the need of manpower planning. What is new are the more efficient planning methods and the improved data bases. What is lacking is application of new planning methods and improved data bases to old and continuing manpower problems.

The term "manpower planning" is subject to various definitions. Manpower planning, as used here, is concerned with the training and development of workers and their distribution among different sectors or industries in the economy. The major functions of manpower planning are: (1) manpower forecasting to provide policymakers with data to assist in decision making, (2) manpower policies to provide ways for integrating manpower needs with overall social and economic goals of the nation, and (3) manpower management.

Manpower planning in a developing country is an important step that should precede, or at least parallel, any plan for a country's overall development. Planning the supply of labor, particularly highly trained

labor, to meet the requirements of future economic growth and development, is essential not only for the developing but also the developed countries. Planning the supply of highly trained labor has to be on a long term basis as the duration of training requires a long period of time. But before one can plan the supply of highly trained labor, one needs to determine the need for this type of manpower in advance. A crucial step toward this planning is to estimate the requirements of manpower by types of skill that are required for future economic growth and development.

1.1 The Need for Manpower Planning and Forecasting in Saudi Arabia

There are many reasons why manpower planning and forecasting is needed in developed or developing countries. There are several reasons why it is needed for Saudi Arabia. Those reasons could be summarized as:

1. The rapid rate of development. The rapid development underway now in the country has brought new requirements in construction activity and in industrial growth of all kinds. There is a great need for workers possessing skill and experience and for workers with no skill at all. The country's current labor force is unable to meet the market demand placed on it as a result of these rapid developments. Importation of labor is a short-term solution. But the importation of a large number of workers has brought with it an increasing demand for food, housing, schooling, and other services which the country is not capable of providing.

2. The rapid rate of population growth. Population is rapidly increasing at about three percent per year [20]. This rapid growth in population is due to the reduction in infant mortality and improved medical facilities. Average life expectancy is expected to rise from 49 years in 1960-70 to 62 years in 1975-85 [125]. In 1970, it was estimated that about 46 percent of the total population was under 15 years of age [90]. This shows that the country has a very young population which reemphasizes the importance of manpower planning.

3. Rising educational aspiration. The social attitudes of the past toward education have changed. Proof of this is the large increase in school enrollment during the past decade. In 1971, the student population amounted to 593,500 compared to 1,452,900 in 1980.[1] Therefore, educational systems should be concerned with the direction of enrollment by students in the appropriate disciplines to reduce the country's reliance on foreign workers and achieve more of a Saudization of the labor force.

4. The availability of resources. Saudi Arabia depends on oil for its revenue. But oil is a non-renewable resource which, with time, will either be depleted or a new source of energy will be discovered to replace it. The Government recognizes this fact and is working to diversify its source of income by creating a sound industrial base. This process in itself requires not only a material investment in building and machinery, but also an investment in human resources development. Trained and experienced manpower is needed to run these industries.

---

[1]See Chapter II.

1.2 Significance of the Research

This research is very important for the future planning in Saudi Arabia. The outcome of the investigation of manpower planning and forecasting in Saudi Arabia and the development of a logical model for manpower demand should be very helpful to government planners, educators, and other decision-makers in the private and public sectors. It is the goal of this research to determine the amount of labor by occupational and educational level needed to obtain the desired goals set forward by the national government and to provide the decision makers with a tool which can be used for analyzing the impact of alternative development strategies.

1.3 Statement of the Problem

It is a well known fact that Saudi Arabia is undergoing a unique experience in national development to which most current economic theories and development models have but limited applicability. The country has made phenomenal strides in progressing from one social and economic phase of development to another in a very short time period. This rapid change has created a cultural gap from which the society is suffering.

The traditional way of life, because of limited economic activities, had no great need for skilled manpower or even a large number of semi-skilled and unskilled workers as is the case today. The rapid development underway now in the country has brought new requirements in construction activity and in industrial growth of all kinds.

A major constraint to the Kingdom's development has risen from the lack of qualified manpower. The major factor which affected the rate of

implementation of development projects during the first development plan (1970-1975) was the shortage of educated and trained manpower. During the second plan (1975-1980), the gap between demand for and supply of Saudi manpower in various skill groups was widened even more (see Table I). Thus, the need for non-Saudi manpower has become more evident The development and progress achieved over the first and second development plans were very costly from the socioeconomic point of view of the Government and the citizens of the Kingdom. This will continue as long as the reliance on foreign workers continues.

TABLE I

GROWTH OF THE CIVILIAN LABOR FORCE
1975-1980

	1975 (Thousands)	1980	Annual Average Growth 1975-1980 (Percent)
Male	1,651	2,323	7.1
Female	96	148	9.0
Total	1,747	2,471	7.2
of which:			
Saudi	1,253	1,411	2.4
Non-Saudi	494	1,060	16.5
Total	1,747	2,471	7.2

Source: [92, p. 35].

The major obstacles in the process of development in Saudi Arabia are shortages of manpower in general and high-level manpower specifically. The civilian labor force (1979-1980) numbers about 2.5 million, of which about 1.1 million are non-Saudi [92]. The shortages are pervasive in the public and private sectors and thwart implementation of economic and social development progress set forward by the Saudi Government. The Ministry of Planning indicated that adequate supply of manpower is very essential

> . . . to accomplish most of the economic development goals of the Kingdom . . . better education, health, housing, community communication and transport, and more productive employment opportunities for the society [91, p. 141].

There were an estimated 69,169 job vacancies in 1976 (Table II). Over one-third, or 35.9 percent, of those vacancies were in the critical skills category--technical, professional, and managerial occupations. Of all those vacancies, about 68 percent were reported in the public sector. Nine out of ten of the technical, professional, and managerial vacancies were in the public sector. This may be due to the difference in wages paid by the private and public sectors to those with technical and managerial skills. The Government recognizes this competition and tries to increase its wages. The last three Government wage increases were in 1973, 1975, and most recently in 1981. The first increase averaged about 15 percent. The second raise was 30 percent on salaries not exceeding SR 1000[2] per month, 26 percent on salaries not exceeding SR 2000, and 20 percent on salaries above SR 2000 per month. The third raise averaged about 50 percent. But with all this, the wages are still rising more rapidly in the private sector than in the Government sectors.

---

[2]SR = $0.31.

TABLE II

PUBLIC SECTOR AND PRIVATE SECTOR LARGE ESTABLISHMENTS REQUIREMENTS BY MAJOR GROUPS OF OCCUPATIONS TO 1980

Occupation	Current Vacancies	Future Requirements 1977	1978	1979	1980	Total Current and Future Requirements	Current Non-Saudi Employees	Requirements due to attrition of Non-Saudis (5% per annum)	Total Vacancies, Future Requirements and Non-Saudi Replacement	Percent of Total
0. Scientific & Technical Professionals and Sub-Professionals	9,978	10,307	6,731	7,614	7,228	41,858	17,333	3,068	44,926	15.1
Public Sector	8,466	8,498	4,944	5,939	6,722	34,569	6,940	1,228	35,797	—
Private Sector	1,512	1,809	1,787	1,675	506	7,289	10,393	1,840	9,129	—
1. Other Professionals	10,584	12,820	10,104	8,891	9,562	51,961	15,954	2,824	54,785	18.4
Public Sector	9,802	11,984	9,590	8,430	9,119	48,925	11,778	2,085	51,010	—
Private Sector	782	836	514	461	443	3,036	4,176	739	3,775	—
2. Administrative and Managerial Workers	4,278	5,060	7,970	9,991	11,482	38,781	4,906	868	39,649	13.3
Public Sector	2,036	4,821	7,939	1,951	11,471	38,218	283	50	38,268	—
Private Sector	242	239	31	40	11	563	4,623	818	1,381	—
3. Clerical Workers	18,760	19,077	7,703	6,482	8,502	60,524	23,857	4,223	64,747	21.7
Public Sector	17,260	16,162	6,645	5,563	7,549	53,179	2,737	484	53,663	—
Private Sector	1,500	2,915	1,058	919	953	7,345	21,120	3,739	11,084	—
4. Sales Workers	514	189	86	86	60	935	1,659	294	1,229	0.4
Public Sector	332	90	57	60	60	599	288	51	650	—
Private Sector	182	99	29	26	—	336	1,371	243	579	—
5. Service Workers	2,631	2,707	2,305	1,216	1,061	9,920	5,246	929	10,849	3.6
Public Sector	1,775	2,641	2,298	1,216	1,061	8,991	282	50	9,041	—
Private Sector	856	66	7	—	—	929	4,964	879	1,808	—
6. Agricultural Workers	102	129	129	47	36	105	185	34	384	0.1
Public Sector	102	94	94	47	36	25	25	4	320	—
Private Sector	—	35	35	—	—	160	160	28	63	—
7/ Production & Related Workers										
8/ Transport Equipment Operators										
9. and Laborers	22,322	23,796	7,487	6,467	6,466	66,538	83,930	14,856	81,394	27.4
Public Sector	5,285	10,362	2,862	2,466	2,717	23,692	1,521	269	23,961	—
Private Sector	17,037	13,434	4,625	4,001	3,749	42,846	82,409	14,587	57,443	—
TOTAL	69,169	74,086	42,423	40,794	44,397	270,869	153,070	27,093	297,962	100.0
Public Sector	47,058	54,652	34,372	33,672	38,735	208,489	23,854	4,222	212,711	71.4
Private Sector	22,111	19,434	8,051	7,122	5,662	62,380	129,216	22,871	85,251	28.6

To minimize the possibility of manpower bottlenecks in the development process and to accelerate the country's potential for development, a well-conceived plan for the supply of this vital resource must be made. Five-year development plans are frequently used in development planning. It should be recognized, however, that it is impossible in the space of five years to introduce substantial changes in the structure of the educational system which is the key to high-level manpower output. Of all the resources required for economic development, skilled manpower requires the longest time for its creation. However, to plan for a sufficient supply of high-level manpower, the first logical step is to forecast its demand, and determine the extent to which it can be met through expansion of the educational system and through imports. The outcome of this study should be helpful to Government planners, educators, and other decision-makers in the private and public sectors.

1.4 Purpose of the Research and Hypotheses

The objective of this research was to develop and apply a methodology to analyze manpower planning in Saudi Arabia. An input-output model was developed to project the country's need of manpower by occupational and educational level. It is important to have the means of forecasting manpower requirements and to choose the best alternative to satisfy those requirements in the short run as well as in the long run. The results obtained by the implementation of this model determine the extent to which labor demand is met through expansion of the educational system and through importation. A basic premise underlying this investigation is the belief that an analysis of the country's future demand of manpower will prove to be helpful to Saudi planners. More

specifically this research had three stages. First, to establish a data base; second, to develop a model to project labor demand; and third, to use the model to analyze the impact of alternative manpower development strategies.

1.4.1 Development of a Data Base

Data concerning the economic activities between the different economic sectors in the country, gross domestic product of each sector, government and private consumption, export, import, . . ., etc., were gathered, calculated and tabulated in a matrix form.[3] Data concerning the distribution among sectors as well as data concerning the level of education possessed by such labor in each occupational classification were collected.[4] These data are used as inputs to the model which was developed as a second objective of this research. More specifically, the following objectives were accomplished by data collection, analysis, and manipulation:

a. Development and estimation of an inter-industry account.

b. Development and estimation of a human resource account.

1.4.2 Development of the Model

The different parts of the model were developed and integrated together to determine the country's labor demand by occupational and educational levels. The model accomplishes the following objectives:

---

[3]The economic sectors which constitute the economy of Saudi Arabia are presented in Chapter V.

[4]The classification of the different occupations in Saudi Arabia are presented in Chapter V.

a. Projection of total sectoral final demand.

b. Projection of the change in sectoral productivity.

c. Projection of sectoral output.

d. Projection of sectoral employment by occupation.

e. Projection of sectoral employment by education.

To determine whether the objectives listed above were accomplished or not, two hypotheses are stated and tested using appropriate statistical procedures. The statistical procedures used to examine the hypotheses are discussed in a later chapter. The formal statement of the hypotheses are as follows:

1. H_0: Final demand can be projected by a casual regression model with sufficient validity to be of value in projecting sectoral output.

   H_a: Final demand cannot be projected by a casual regression model with sufficient validity to be of value in projecting sectoral output.

2. H_0: Sector employment can be expressed in terms of an input-output model with sufficient validity to be of value in the planning of the educational system.

   H_a: Sector employment cannot be expressed in terms of an input-output model with sufficient validity to be of value in the planning of the educational system.

1.4.3 The Model as an Analytical Tool

The model as discussed is used as an analytical tool to provide manpower data to help guide economic and educational planners to achieve the country's goal of full Saudization of the labor force. More specifically, the model should help Government planners in the following ways:

a. Provide the economic planners with a logical model to analyze the impact of alternative development strategies. This is done by

allowing planners to experiment with different growth rates of the independent variables in the model.[5] The total labor required to achieve the desired sectoral output changes with changing growth rates of these variable and labor productivity.

b. Provide the educational planners with guidelines in directing students to fields of specialization that will minimize, or hopefully prevent, shortages and excesses of manpower in each occupation in the future. In other words, it will help educational planners to fill future manpower needs of the rapidly growing industries in the country with Saudi workers.

---

[5]See Table XXXVIII.

CHAPTER II

THE FACTORS AFFECTING THE GROWTH AND UTILIZATION OF MANPOWER

To project labor demand for a country and to determine the potential to meet this demand, one must examine the factors affecting population growth, social and cultural values of the people, and attitudes toward work. This chapter starts with a brief background of Saudi Arabia, then examines factors affecting population growth. Social and cultural values and their influences on people's participation in the labor force are also discussed. Finally, improvements in the education and health services are presented.

2.1 Background of Saudi Arabia

The Arabian Peninsula, which is located in Southwestern Asia, is the largest peninsula in the world. It is slightly over a million square miles or about one third of the size of the United States of America [73]. Saudi Arabia occupies approximately 80 percent of it, or about 860,000 square miles, an area roughly equivalent to the United States east of the Mississippi [99].

The Kingdom has as its neighbors on the northern boundaries the Hashemite Kingdom of Jordon, Iraq, and Kuwait, the two Yemen Republics and Oman on the south, the Arabian Gulf, Bahrain, the United Arab Emirates, and Qatar on the east, and by the Red Sea on the west (see

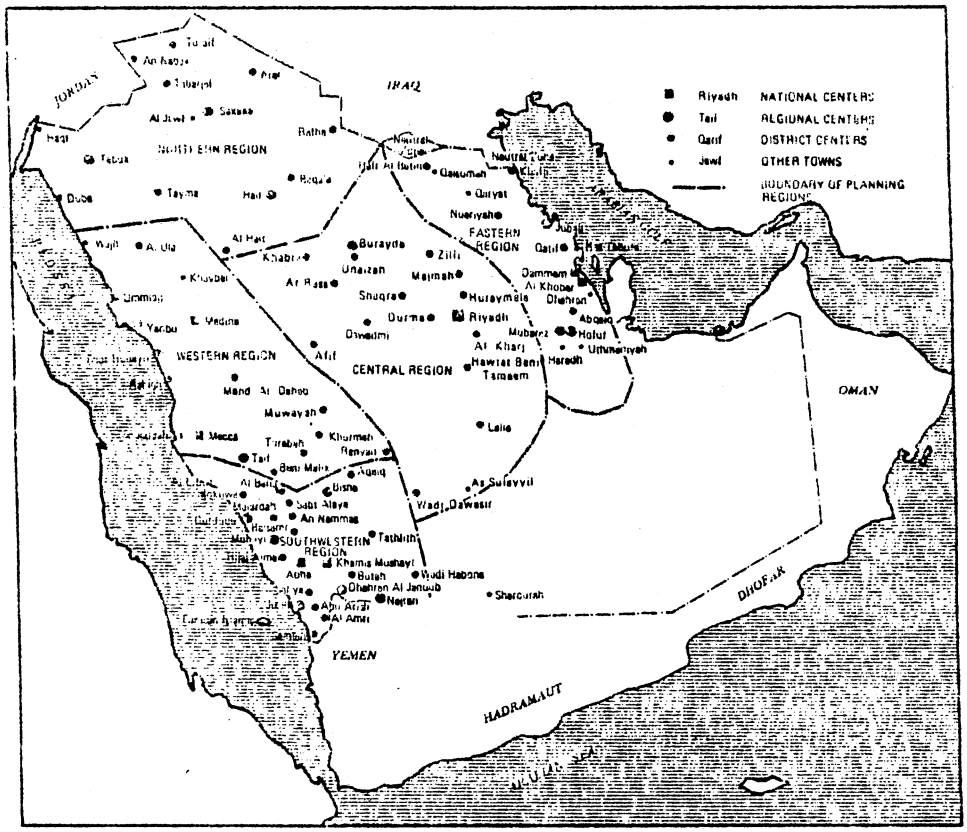
Figure 1). Thus, the Kingdom is of geographical importance because of its location between Africa and Asia, its closeness to the Suez Canal, and its frontiers on both the Red Sea and the Arabian Gulf. Its location is very strategic to the West because most of the oil needed by the West to keep its industries in operations goes through the Arabian Gulf and the Red Sea.

The country has five settled regions, of which one is the Eastern region located along the Arabian Gulf which contains the wealthy oil fields. The second region is the Southwestern region which runs north of the Yemen border and is full of mountain ranges. The third region is the Northern region which runs south of Jordan and Iraq. The fourth region is the Central region which contains the city of Riyadh, the capital, and finally the fifth region is the Western region which is situated along the Red Sea Coast where the city of Jeddah, the main seaport, and the holy cities of Mecca and Medina are located.

Government is a theocratic monarchy whose constitution is the Holy Koran. Islam is the official religion and plays a dominant role in the day-to-day life of the people. The official language of the Government is Arabic. Thursday and Friday comprise the offical weekend, with Friday as the weekly religious holiday.

2.2 The Rate of Population Growth, Distribution, and Age Structure

The population of Saudi Arabia cannot be estimated with any degree of accuracy because of the high percentage of foreigners in the country and the fact that there is no well-defined boundary. The first census was conducted in 1962, covering only the five largest cities (Jeddah,



Source: [92, p. xxxiv].

Figure 1. Map of Kingdom of Saudi Arabia

Mecca, Medina, Riyadh, and Taif). It is estimated that the total population is between 3.2 to 3.3 million as compared to previous estimates of 5 to 7 million [84]. The most recent census conducted by the Saudi Government was in late 1974. It puts the total population of the country at slightly over 7 million (see Table III).

In 1962-63, an establishment survey estimated the number of economically active Saudi men at 662,000 [89]. Birks and Sinclair [20] estimated the total population in 1962-63 at 3,310,000. They arrived at this figure by taking the establishment survey estimation and assuming that only about 20 percent of the total population of Saudi Arabia in 1962-63 were economically active. In the same year, the Economic Research Institute of the American University of Beirut estimated the country's total population between 3 and 3.8 million [10]. Its estimate was based on comparisons of food availability to consumption standards required to support life. The authors of the area handbook for Saudi Arabia wrote:

> Many analysts estimated that in early 1976 the population was about 5.6 million, of which between 1 million and 1.5 million were foreigners. The estimates of other reputable observers were as low as 4.7 million, of which only about 3.2 million were Saudis [99, p. 45].

Most of the analysts underestimated the total population of Saudi Arabia while the Government overestimated it. There are two main reasons for this. First is the existence of two of the three Muslim holiest cities (Mecca and Medina) in the country which result in illegal settlement in those cities by pilgrims coming from other Muslim countries.[1] Secondly, a good percentage of the population is nomadic or semi-nomadic which makes their counting a difficult job, especially for

---

[1]The third city is Jerusalem.

TABLE III

POPULATION OF SAUDI ARABIA BY ADMINISTRATIVE AREA, 1974

Administrative Area	Number of Demographic Units[a]	Number of Families	Population			
			Sedentary	Nomadic	Percentage of Nomadic to Total Population	Total
Riyadh	1,992	198,936	965,805	306,470	24.0	1,272,275
Mecca	4,088	325,789	1,513,634	240,474	13.7	1,754,108
Eastern Province	667	120,684	690,188	79,460	10.3	769,648
Asir	4,597	127,131	434,884	246,477	36.2	681,361
Medina	1,742	98,835	282,195	237,099	45.7	519,294
Jizan	4,537	85,483	387,161	15,945	4.0	403,106
Qasim	509	48,724	215,447	101,193	32.0	316,650
Hail	504	45,338	117,210	142,719	54.9	259,929
Tabuk	472	33,642	105,388	88,375	45.6	193,763
Al-Baha	1,296	34,323	156,997	28,908	15.5	185,905
Najran	242	26,569	91,555	56,415	38.1	147,970
Northern Frontiers	130	19,345	42,666	86,079	66.9	128,745
Jawf	85	10,243	34,093	31,401	47.9	65,494
Qurayyat	98	5,873	18,432	12,972	41.3	31,404
Frontier Nomads	--	30,000	--	210,000	--	210,000
Saudis resident abroad at time of census	--	--	73,000	--	26.8	73,000
TOTAL	20,995	1,210,915	5,128,655	1,883,987		7,012,642

[a]Demographic units: consisting of towns, villages, settlements, farms, water wells, and nomad agglomerations.

Source: [4, p. 186].

for an outsider. But these reasons by no means are enough to keep the country's population fixed over a 15-year period. Assume that the estimate published by the Economic Research Institute of the American University of Beirut, which is in full agreement with the estimate given by Birks and Sinclair earlier, was right and assume a natural growth rate of 2.5 percent for the years between 1963-1970, and a natural growth rate of 3.0 percent for the years between 1970-1976, then the total population in 1976 should be between 4.36 million and 5.53 million. Then, in 1980, it should be between 4.91 million and 6.22 million.

The natural rate of growth of the Saudi population is uncertain due to inadequate reporting of births and deaths in the country. In 1970, Saudi officials estimated an annual birth rate of 47.5 per 1,000 and a death rate of 20 per 1,000, which results in a 2.75 percent annual growth rate in the population. Three years later the United Nations estimated the country's population growth to be 2.97 [138]. The average life expectancy was 43 years in 1960 and 54 years in 1979 [143]. Infant mortality rate was estimated at 260 per 1,000 live births in 1962 [143]. This rate stands at about 150 per 1,000 in 1980, which is still high when compared to other countries (see Table IV). The increase in life expectancy and the decrease in infant mortality are due to the continuing improvement in health service and education. Improvement in both health service and education will be discussed later in this chapter.

Saudi Arabian population is very young and progressive. In 1962-63, the Government census showed that about 68.6 percent of the population was under 30 years of age [84]. In 1970, the first development plan

TABLE IV

INFANT MORTALITY RAE IN SOME SELECTIVE COUNTRIES, 1980

Country	Number of Deaths in Each 1,000 Newborns
Average infant mortality rate in the world	98
Advanced world	21
Third world	116
Africa	140
Algeria	142
Egypt	90
Libya	130
Morocco	133
Sudan	141
Tanzania	125
Bahrain	78
Iraq	104
Jordan	97
Kuwait	39
Lebanon	65
Oman	142
Qatar	138
Saudi Arabia	150
Syria	114
United Arabia Emirates	138
Yemen Arab Democratic	160
Democratic Republic & Yemen	155

Source: [118].

estimated that about 45 percent of the total population was under 15 years of age [90]. Because of the obvious social and economic similarities, Assaf used the recent census of Bahrain as a proxy for determining the age distribution of Saudi Arabia's population [11]. He found that about 50 percent of the population of Saudi Arabia is in the age group 15-64 years old and about 40 percent are in the age group 20-60 years of age. This means that, at maximum, 50 percent of the population are capable of being economically active and, at a minimum, 40 percent can be economically active. In reality, not even 30 percent of the population are economically active because of low participation by women in the labor force and the attitudes of Saudi youth toward work.

The youthful feature of the population results in a low productivity and high dependence ratio. But the youthfulness and size of the population alone cannot be held responsible for the shortage in skilled and unskilled labor which the country is facing. In reality, the existence of a very complex set of social and cultural values, the nomadic population, the health service, and the educational system are the main reasons for the low participation of Saudis in the labor force and their low productivity. These factors mentioned above are subject of the next sections.

2.3 Social and Cultural Values

In developing countries, social and economic factors frequently combine to place severe constraints on economic development. The most severe economic constraint is lack of capital. However, this is not the case in Saudi Arabia where capital has been available. What limits development in Saudi Arabia is the existence of a complex set of social,

cultural, and institutional relationships.

Educational institutions play a fundamental role in the development of the necessary skills for basic development; yet, other institutions determine how many people go through the educational system. Thus, attitudes, social values, and institutions affect the utilization of manpower, and shape the division of labor between the sexes.

Dualistic systems of traditional tribalism and modernism exist side by side in Saudi Arabia. In both systems, family is the center of the social structure, and loyalty to the family overshadows all other obligations, tribe, and country. A Saudi's loyalty is to his family first, then his tribe, then to his country. Rural as well as urban Saudis take pride in maintaining loyalty to the tribe to which an individual belongs. The social status of a Saudi man is determined by the social status of his family, his tribe, or the region from which he originates. An individual's well-being is the responsibility of the whole family. Likewise, the family's well-being is the individual's primary concern. Nepotism in Saudi Arabian society is considered a duty. The person should do this for his family, relatives, and friends. If an individual reaches a high public position or acquires wealth, he is obligated to extend a helping hand, not only to his closest relatives, but also to his distant cousins and friends.

Classes of people in Saudi Arabia exist on a social scale. At the top of the social structure is the royal family and its branches. Below the royal family is a lower upper class, consisting of wealthy merchants and landowners, high government officials, and the leading members of the Ulama. The lower class consists of Bedouins and herdsmen and semiskilled and unskilled workers who are employed by the private

sector and the Government. Until after World War II, a middle class did not exist in Saudi Arabia except for a very few merchant families in the major seaport towns along the coast of the Red Sea and the Arabian Gulf.

The middle class emerged with the transformation of the country from a traditional economy based on herding, to a modern economy based on the exploitation of oil and the expanding role of Government. This transformation required many trained personnel and engineers which the country lacked. To overcome this, the Government started sending young Saudi males abroad for advanced training in these fields. Those young men who are educated abroad and those who receive higher education at home are the base of the middle class in the country. The middle class grows with the growing number of educated people in the country. This class is stratified into an upper and lower division. The upper division consists of engineers, physicians, high-level Government officials, university teachers, and some businessmen. The lower division consists of school teachers, skilled blue-collar workers and lower-grade Government officials.

People who are working as tinkers, blacksmiths, shepherds, plumbers, etc., are considered unclean and are unacceptable for people who classify themselves as true Arabs. The prestige attached to a job is very important in the choice of occupation. Many of the Bedouins come to town to settle with little or no education and no skills valuable to modern industrial, commercial, or bureaucratic pursuits. Their own dignity prevents them from accepting an unskilled job because, in their way of thinking, they associate this kind of job with lowborn peasants and not with members of noble tribes such as theirs. This attitude leaves them with little choice of the kind of job they consider noble. In fact, the

only kind of noble work they can do is soldiering and taxi-driving. Knauerhase [69] wrote that:

> A man will accept considerably lower wages for a given job if he considers it socially more prestigious. For example, graduates of the Riyadh Vocational Training Center are given a set of tools required in their trade upon completion of training. It is not unusual for a man to sell these tools and use the proceeds as a downpayment for a taxi. Although he could probably earn more as a plumber or other artisan, he prefers driving a taxi for prestige reasons [p.28].

This attitude of the Saudi youth toward manual and vocational education has not changed. Al-Ghofaily [3] found in a recent study that about 80 percent of the Saudi youth do not accept manual labor and that most vocational students entered vocational schools not because they had a desire or interest, but because they were not accepted in the academic schools. This attitude must change in order to reduce reliance on foreign workers and to increase participation of Saudi youth in the labor force.

Saudi Arabia is more influenced by Islamic religion than any other Muslim country. It is the only country among the major Arab states which asserts the literal truth of the Koran and also that of its commandments, legal as well as ritual. The main reasons could be because it contains two of the three holy cities of Islam, Mecca and Medina (the third being Jerusalem). Mecca is the place where the sacred shrine exists, to which Muslims from around the world face five times a day in prayer. Mecca is also the place where the prophet was born. Medina is the place where the prophet died.

The Koran, the sayings and teachings of the prophet, and the conduct of the first generation of believers are the sources of values and law in Saudi Arabia. The Koran is the only constitution of the country. Separation of religion and state, as is the case in Western societies, does not exist in Saudi Arabia. There is no concept of an

established church or of the church as an institution. Islamic policy in state and church is one. It is both an institution and a body of doctrine supervised by the head of state, the King.

Islam is a complete way of life to Muslims. The rules of Islam are pervasive in the lives of the Saudis. Its rules govern an individual's public and private behavior, his relationships with others, and his devotion to God. It controls his social and economic way of life. Islam prohibits intoxication, interest on loans, and mixed gatherings.

Segregation of the sexes, at least in public, is absolutely basic to Saudi social life and is enforced by law. Mixed social gatherings, in spite of all this, still exist in the country among a few highly sophisticated Saudis who have been educated abroad. The increase in wealth and the openness of the country to foreigners who aid in the development of the country has encouraged mixed gatherings.

The role of women in Saudi Arabian society has been severely circumscribed. Saudi women have led extremely private lives, in which the husband is the complete master of his family and household activities. They cannot drive cars or attend classes with men. They have very limited job opportunities besides being a housewife. They can only work as teachers in girls' schools, as social workers, and as nurses to a lesser extent. Thus, the role of women is considered very limited in Saudi Arabia. By Western judgment, Saudi women are considered inferior in the society because it is a male-dominated society.

In Saudi Arabia, today Islamic factors continue to shape the changes which may be made in the modalities of life for the Saudi women. However, this does not make them inferior to men. Currently the role of women as full participants in the development of the country has begun

to change. Even so, this change is taking place very slowly. Writing on the role of women in its report, "Labor Development Abroad," the United States Department of Labor [140] wrote:

> Women of Saudi Arabia are emerging from their traditional secondary role in Saudi life as a result of community development projects initiated by the Government. For the first time in history, and despite initial strong opposition from local inhabitants, education for women was introduced in the model community development project in Dariyyah in 1961. The first course began with 12 girls; by the end of 1963, 2,567 girls were attending classes in 14 development centers throughout the Kingdom [p.20].

The urban Saudi women of today are working as doctors, university professors, bank directors, journalists, college deans, and radio announcers, to mention just a few of the new occupations into which they have moved [13].

In the nomadic and desert society, women fulfill important economic functions without which the family cannot survive. The Bedouin women occupied and continue to occupy a very important position in the family and enjoy a much greater freedom than their counter-sisters in town. In the past, the Bedouin women used to haul water on the back of camels. Now they drive trucks instead.

Today Saudi Arabia may have one of the lowest, if not the lowest, participation ratio for women in the labor force of any country in the world. In 1965, no Saudi female teachers were employed in Government schools [86]. In 1980, there were 11,847 working full time and, in 1982, the Government employed about 25,000 [83]. The second five-year plan estimated that about one percent of the female population in 1975 joined the work force [91]. The central planning organization estimated that if the participation rate of women in the work force increased to 20 percent in 1990 instead of the projected five percent figure, with a

concurrent reduction in non-Saudi labor, Saudis would account for 81 percent of the labor force in 1990 instead of the projected 70 percent [64]. This is clearly a waste of human resources. The work restriction on women represents formidable barriers to economic development, but Saudi women are still incapable of fulfilling the country's need for female teachers. The supply of labor would increase and the reliance on foreign workers would decrease if the job opportunities for women and their motivation to work increase. Most Saudi women, upon their marriage, quit school and work, while others finish school and study at home waiting for a husband. Those who finish school and want to work are unwilling to work in any place except where their families live. The participation of women in the labor force will not increase unless the Government provides more job opportunities for women within the Islamic doctrine and women themselves must change their attitude toward work.

The Bedouin nomads represent another social phenomenon with important implications for the economic development of the country. The 1974 census revealed that about 27 percent of the total population is nomadic. The Minister of Planning stated in an interview that the Bedouins constitute about 24 percent of the labor force while they contribute only 2.5 percent to the GNP [7]. Based on those facts, one can easily recognize the important role the nomadic population can play in meeting the growing demand for labor in the expanding modern sectors in the country, such as construction and manufacturing sectors.

2.4 Literacy and Educational System

From the early 19th century until about the mid-fifties, the only concern of educational systems in the area now known as Saudi Arabia was

the teaching of the Koran, Classical Arabic, writing, and arithmetic. The private sector was behind the creation of those schools. In reality, Government schools did not yet exist. It was not until 1954, with access to increased revenues and the elevation of the Department of Education to Ministry status under the direction of His Majesty King Fahd Ibn Abdulaziz, that modern education for boys began to extend systematically throughout the Kingdom [105]. Education of girls was practically non-existent at that time because of a strong attitude against female education. The conservative aspects of traditional life were preferred by the majority of the population. In spite of this, a few families were committed and determined to educate their daughters either at home or by sending them abroad. In 1957, the first modern private schools for girls were opened in Jeddah. Not until three years later did Government-run schools open [67]. The brief history of education above reflects the short life of education, less than 30 years, in Saudi Arabia. The founder of this country, His Majesty King Adbulaziz Ibn Saud, knew from the start that a country's true asset is its people. He foresaw education as the initial point of departure in the movement of any social group or country to alter its status and opportunities. He made education free of charge for every citizen, starting from primary up to and including higher education.

Currently, things are changing because the male-dominated society is gradually freeing itself from its traditional attitudes towards women. Table V shows enrollment by sex in absolute numbers and as percentages of total population for some selected years. In 1962, only 11.6 percent of the total number of students were female, and about 6.5 percent of the total population were in school. Ten years later, in

1972, the percentage of female students jumped to about 28.4 percent of the total students, while both male and female students represented about 17.4 percent of the total population. At the end of 1980, close to 30 percent of the population were in school, of which females represented about 39 percent. It is clear that the percentage of females in education did rise with the passage of time and the gap between female and male enrollment is closing.

The tremendous expansion of females' education may reflect a growing acceptance of their contribution to the society by the male-dominated society. This universalization of female education will create in the long run strong pressures to find suitable avenues for them to use what they have learned.

Saudi Arabian school systems are considered biased in favor of the traditional Islamic education. This bias is very clear in higher education. The country, at this time, has seven major universities:

1. College of Shari-ah and Islamic Law, established in 1949 at Mecca. It is now called the University of Omm Alqura.

2. College of Shari-ah and Islamic Law, established in 1953 at Riyadh. It is now called Imam Mohammed Ibn Saud Islamic University.

3. University of King Saud, established in 1957 at Riyadh (previously Riyadh University).

4. Islamic University in Medina in 1961.

5. University of Petroleum and Minerals at Dhahran, 1963.

6. The University of King Abdulaziz, at Jeddah in 1967, at Medina in 1977.

7. University of King Feisal in Dammam and Al-Ahsa in 1975.

Three of the seven universities, Omm Alqura, Imam Mohammed Ibn

TABLE V

NUMBER OF STUDENTS BY SEX AND AS A PERCENTAGE OF THE POPULATION IN SELECTED YEARS (THOUSANDS)

Year	Males	Females	Total	Approximate Population*	Students as % of Population
1958	109.8	--	109.8	3000.0	3.7
1960	131.2	11.7	142.9	3152.0	4.5
1962	191.0	25.1	216.1	3311.0	6.5
1964	254.0	48.0	302.0	3479.0	8.7
1966	303.5	79.6	383.1	3655.0	10.5
1971	440.4	153.2	593.6	4156.0	14.3
1972	484.2	181.2	665.4	4280.0	15.6
1973	534.0	211.9	745.9	4469.0	16.9
1974	594.9	255.3	850.2	4541.0	18.7
1975	667.9	310.1	978.0	4677.0	20.9
1976	705.3	352.7	1058.0	4818.0	22.0
1977	752.7	390.6	1143.3	4962.0	23.0
1978	793.6	420.9	1214.5	5111.0	23.8
1979	865.6	463.7	1329.3	5264.0	25.3
1980	942.9	510.0	1452.9	5422.0	26.8

*Population was obtained based upon three million in 1958 and a rate of growth of 2.5 percent from 1958-1970, and three percent from 1971-1980.

Sources: 1958-1966--[29, p. 44].
1971-1975--[30, p. 36].
1976-1980--[31, p. 40].

Saud, and Islamic University, are emphasizing traditional Islamic education.

The progress of all levels of education in the country during the past decade is shown in Table VI. Technical education is the lowest form of education attracting Saudi youth. In 1970, female enrollment in higher education was 6.3 percent. This figure jumped to 26.4 percent in 1980 [87]. Some of the factors behind this increase are an increase in the number of high school graduates, an increase in awareness of education's importance, and heavy Government subsidies for higher education. Theoretically, hard economic conditions and shortages of jobs send former students back to school and encourage the ones who are in school to continue their education. This was believed to be the reason for higher college enrollment in the United States after the 1974 recession and now. However, this does not apply to Saudi Arabia because the country's universities are far behind in producing graduates to meet the country's demand for educated laborers. College graduates are guaranteed a job by the Government.

Because of the expansion of the formal education system, enrollment in all levels of education has increased. This increase has two major effects on the economy. First, it increases the dependence ratio. Secondly, it decreases the participation of Saudi youth in the labor force, since they spend more time in school. The participation rate for males between the ages of 12 and 14 dropped from 37 percent in 1975 to 21 percent in 1980 while the overall male participation rate also dropped from 69 percent to 65 percent over the same period (Table VIII).

TABLE VI

PROGRESS IN EDUCATION DURING THE 1970'S

Year	Number of Schools	Number of Teachers (Fulltime)	Number of Students (Thousands)									
			Pre-school	Elementary Education	Intermediate Education	Secondary Education	Higher Education	Teacher Training	Technical Education	Adult Education	Other	Total
1970	3,107	23,118	4	397	61	16	7	11	1	43	5	545
1971	3,283	23,856	6	428	70	20	8	14	1	43	5	595
1972	3,659	27,627	7	475	84	23	9	15	1	46	7	667
1973	4,254	31,907	8	521	100	27	11	14	1	55	9	746
1974	4,697	37,942	10	578	116	33	15	14	2	72	10	850
1975	5,634	43,777	14	634	137	42	19	15	3	100	14	978
1976	6,536	51,176	16	686	155	49	26	15	4	95	12	1,058
1977	7,497	58,201	16	726	178	60	32	15	5	99	12	1,143
1978	8,695	63,557	18	753	197	70	41	20	5	106	10	1,220
1979	10,018	70,468	23	803	220	84	44	21	5	122	7	1,329
1980	11,070	78,309	34	862	245	93	48	22	6	142	10	1,452

Source: [93, p. 129].

TABLE VII

MALES' PARTICIPATION RATES IN LABOR FORCE 1975 AND 1980 (IN PERCENTAGES)

Age Group	1975	1980
12-19	37	21
20-29	83	83
30-44	95	95
45-59	88	88
60+	51	46
All males	69	65

Source: [92, p. 36].

2.5 The Health Service

The nation's public health and medical care system was neglected and assigned a low priority in the allocation of the Kingdom's revenues compared to the educational system (see Table VIII). The educational budget has been more than three times as much as the health budget during the past years. During the past decade, the health budget increased by about 32 percent per year. This increase, however, does not match the increase in the Government budget of 37 percent per year. This reflects a decline in its relative share of total Government budget. An only explanation of this shortfall in public health is that this sector is a highly capital intensive sector which requires a highly

trained staff. Highly trained medical personnel are difficult to find in Saudi Arabia.

TABLE VIII

COMPARISON OF THE GROWTH IN EDUCATION AND HEALTH BUDGET IN SELECTED YEARS IN MILLION OF S.R.

Year	Government Budget	Education Budget	Education Budget as % of G. B.	Health Budget	Health Budget as % of G.B
1965	3,961	514	13.0	163	4.1
1968	4,937	524	10.6	148	3.0
1970	5,966	602	10.1	200	3.4
1971	6,380	667	10.5	183	2.9
1972	10,782	1,150	10.7	288	2.7
1973	13,200	1,592	12.1	429	3.3
1974	22,810	2,233	9.8	594	2.6
1975	45,743	3,760	8.2	1,182	2.8
1976	110,935	12,941	11.7	3,230	2.9
1977	131,296	13,977	10.7	2,995	2.3
1978	134,254	15,049	11.2	3.430	2.6
1979	144,558	15,155	10.5	4.094	2.8
1980	185,821	17,396	9.4	4,236	2.3

Source: [29, 30, 31].

In spite of this shortage of medical personnel, the country has come a long way in providing medical services to its population. In 1964, there were only 46 hospitals with 4,902 beds in the country, concentrated in the heavily populated cities [85]. The data presented in Table IX represents the continuing improvement in the quality of medical services as reflected by the ratio of hospital beds per physician. This

ratio was eight hospital beds per physician. Ten years later, the ratio declined to 3:1. The ratio between nurses and physicians declined from 3:1 to 2:1. This ratio should have increased because one physician can supervise more nurses than he is currently assigned.

Despite remarkable progress in health services during the past decade, the country still suffers from a lack of safe water supplies, sewage networks and distribution of health services. Top priority should be given to improve preventive medicine, improve nutrition, housing, water supplies, etc. Improvements in the state of health are not likely to materialize by increasing the number of physical facilities and staff alone. Progress must be made in preventive medicine and distribution of health services.

Improvement of health services and the educational system continues to have a noticeable effect on the rate of growth of the population and labor force. Most important effects are an increase in life expectancy, a decrease in infant mortality, higher participation rates among older people and an increase in labor productivity. The improvement of the health services and the expansion of the educational system alone cannot be expected to improve the population rate of participation in the labor force. The social and cultural factors play a very important role in determining how many people enter the educational system and who and when they will join the labor force.

TABLE IX

PROGRESS IN HEALTH SERVICES DURING THE 1970'S

Year	Number of Hospitals, Dispensaries, Clinics, Etc.	Hospitals		Medical & Para-medical Personnel		
		Number	Number of Beds	Physicians	Nursing Staff	Technical Assistants
1970	665	74	9,039	1,172	3,261	1,741
1971	674	75	9,837	1,316	3,355	2,022
1972	701	80	10,101	1,440	4,370	2,230
1973	752	85	10,919	1,783	4,859	2,674
1974	820	90	11,161	2,641	5,891	3,215
1975	878	96	12,111	3,107	6,606	3,552
1976	1,001	98	12,232	3,699	7,878	4,159
1977	1,071	99	13,346	4,075	8,359	4,440
1978	1,138	102	13,745	4,556	8,700	4,749
1979	1,180	98	15,102	5,130	10,278	5,355
1980	1,283	104	17,523	6,461	12,255	6,524

Note: The above statement covers all health facilities offered by, in addition to the Ministry of Health, the private sector and Government agencies other than the Ministry of Health. The figures are provisional and subject to revision.

Source: [93, p. 136].

CHAPTER III

SAUDI ARABIA EXPERIENCES WITH PLANNING

The purpose of this chapter is threefold. The first purpose is to give a very brief introduction to the role of comprehensive planning as compared to partial planning. The second purpose is to review briefly the history of planning in Saudi Arabia prior to the introduction of the first development plan. The different committees or organizations are discussed which were in charge of the planning function prior to the formation of the Central Planning Organization (CPO) and later the Ministry of Planning (MOP). Third, three development plans issued by the MOP are discussed as well as an outlook into the fourth development plan.

3.1 Role of National Planning

There are two distinct types of Government planning, namely, "partial" and "national". The former is concerned with a sector or branch of the economy while the latter is concerned with the entire economy. This study is concerned with national rather than the partial economic planning. Myrdal [98] defines this type of planning as follows:

> Planning conscious attempts by the government of a country . . . usually with the participation of other collective bodies . . . to coordinate public policies more nationally in order to reach more fully and rapidly the desired ends of future development . . . [p. 20].

The definition implies reallocation of the available resources from a less productive sector to a more productive one. In other words, the development of the key sectors is necessary. Before attempting to develop those key sectors, one needs to identify them. As seen later, the input-output technique helps in pinpointing key sectors.

The first step in national planning is the determination of the desired rate of growth the country is seeking to attain. The most common and appropriate measures of economic development are expressed in terms of such quantities as GDP, private and Government consumption, investment or employment, the general rate of development may be most appropriate set out in these terms as a set of economic targets for the country's future plan [139]. Upon determining the desired rate of development, coordination among the different agencies in the country is required to achieve those targets. Tinbergen [129] indicated that planning is characterized by the following features:

1. A plan refers to the future.

2. It is based on a number of objectives which have to be specified.

3. It requires coordination of the means of economic policy to be used in order to achieve these objectives.

National economic development planning implies structural changes in the economy due to the different rates of growth of the different sectors of the economy. Accordingly, it is very important to divide the economy into sectors and to plan the appropriate rate of development of those sectors. Thus, it requires detailed information about the whole economy and the production structure.

There are several planning techniques available in the literature

[133]. Some of those techniques are input-output, linear programming, and econometric. This study will utilize the input-output technique because it is more powerful in depicting the inter-relationships between the different sectors of the economy.

Before attempting to analyze the development plans in Saudi Arabia with respect to manpower, it is necessary to realize that economic development, in order to mean anything at all, must include the dvelopment of the productive capacities of the people themselves. Revenue from oil does not in itself improve the capabilities of people; it can only provide the material means to acquire outside expertise to assist in the development of these capabilities.

3.2 Formal Planning in Saudi Arabia Before 1970

Saudi Arabia's economic development began about 1948 [68]. But formal planning for achieving accelerated economic growth was first thought of in a practical manner in Saudi Arabia in August of 1958 as an outgrowth of the exchange crisis of 1956-1957. Upon a suggestion by Dr. Anwar Ali, King Feisal, then Prime Minister, ordered the formation of the Economic Development and Technical Aid Committee (EDTAC).[1] The committee was charged to develop a five-year plan by studying all ministrial projects and proposals during the period from 1959 to 1964, evaluate them, and submit a report to the Prime Minister [46]. The committee was diverted from its basic function of economic development and was occupied with the examination of applications of the erection of protective tariffs by some businessmen and applications for exemption

---

[1]Dr. Anwar Ali was an officer in the International Monetary Fund and later became a Governor of the Saudi Arabian Monetary Agency.

from custom duties by others. Due to this fact, the committee itself was unsatisfied with its accomplishment. It proposed the formation of a new and more comprehensive planning organization.

In the spring of 1960, the International Bank for Reconstruction and Development (IBRD), at the request of the Saudi Arabian Government, sent a mission to advise the country on development policies. The mission recommended that replacement of the EDTAC by the Supreme Planning Board (SPB) to be headed by the Prime Minister as a chairman, the Minister of Finance and National Economy as vice-chairman, and the memberships of other ministers. The SPB was charged with the overall responsibility for planning, the coordination of the strategies of economic development of the various ministries, and the monitoring of the execution of a coordinated development plan [48].

The SPB failed to function as a planning board and instead serviced as a subcommittee of the Council of Ministers. This led the Government to seek more outside help which the Ford Foundation provided. In January 1965, the foundation suggested the replacement of the SPB by the Central Planning Organization (CPO). Only planning functions were placed within the jurisdiction of the CPO. It took the CPO five years to produce the first formal five-year development plan for the country [46].

3.3 The First Development Plan [FDP] (1970-71 to 1974-75)

On August 16, 1970, the first development plan for a five-year period, 1970-71 to 1974-75 was submitted to the Council of Ministers. The policies necessary to accomplish the objectives of the plan were:

1. Increasing the rate of growth of GNP;

2. Developing human resources so that the several elements of society could contribute more effectively to production and participate fully in the process of development; and

3. Diversifing sources of national income and reducing dependence on oil through increasing the share of other productive sectors in GDP [90].

The actual growth rate for the 10-year-per-plan period of GDP was approximately 10 percent per year. The project growth rate of GDP during the FDP period was 9.8 percent per year, but actually the economy registered a growth rate of 13.2 percent instead. Table X shows the growth rate of GDP by economic sector during the FDP period. The oil and non-oil sector growth rates were 14.9 and 11.0 percent, respectively. Growth of the oil sector exceeded the plan's projected growth rate of 9.1 while the non-oil sector fell short by 1 percent of achieving the target of 12.0 percent. The short fall of the non-oil sector was caused mainly by the failure of the agriculture and manufacturing sectors to achieve the projected annual growth rate of 4.6 and 14.0 percent set forth by the FDP. The other sectors of the economy achieved a higher rate of growth than the projected growth rates envisioned in the plan.

The distribution of the financial allocation to the different sectors of the economy is shown in Table XI. Defense received the largest share of the projected outlays, accounting for 23.1 percent. Social services received second with 22.5 percent of total projected outlays. Agriculture and manufacturing sectors received 3.6 and 2.7 percent, respectively. This could be one of the reasons for the low performance

TABLE X

GROSS DOMESTIC PRODUCT BY SECTOR DURING 1971-1975
(MILLIONS OF SAUDI RIYAL IN CURRENT PRICES)

	1971	1972	1973	1974	1975
Producing sectors:					
Agriculture	1,016	1,059	1,139	1,242	1,392
Mining	51	58	91	147	264
Manufacturing	484	543	617	729	1,599
Utility	298	302	319	328	195
Construction	1,007	1,174	1,809	2,720	7,719
Services sectors:					
Trade	1,068	1,177	1,554	2,355	3,897
Transport	1,479	1,567	2,121	2,718	2,310
Finance	1,104	1,211	1,523	2,079	3,107*
Services	265	297	339	403	523*
Government	1,805	2,145	2,533	3,490	4,990
Oil sector:	14,055	18,373	28,095	82,692	110,462

Source: [91, p. 21].

TABLE XI

SECTOR DISTRIBUTION OF FINANCIAL ALLOCATIONS
FOR THE PLAN, 1970-1975
(SR MILLION)

Sector	Recurrent*	Project	Total	
			Amount	Percent
Administration	6,794.6	922.8	7,717.4	18.6
Defense	3,980.0	5,575.0	9,555.0	23.1
Education, Vocational Training and Cultural Affairs	6,150.2	1,227.5	7,377.7	17.8
Health and Social Affairs	1,612.9	308.2	1,921.1	4.7
Public Utilities and Urban Development	1,246.9	3,325.4	4,572.3	11.1
Transport and Communication	1,767.3	5,709.2	7,476.5	18.1
Industry	321.8	776.7	1,098.5	2.7
Agriculture	973.8	493.9	1,467.7	3.6
Trade and Services	83.5	43.8	127.3	0.3
TOTAL	22,931.0	18,382.5	41,313.5	100.0

*Expenditures covered salaries, wages, transfers and subsidies and other current expenses.

Source: [90, p. 43].

of those sectors during the plan period. The Government relied heavily on the private sector to pick up the slack and contributed to the diversification of the economy. The low absorption capacity of the agricultural and industrial sectors, due to the requirement of highly trained labor which the country is lacking, could be another reason for the low performance of those sectors.

In 1965, the labor force totalled about 1,006,600 Saudi and non-Saudi male and female workers. This number increased by about 3 percent per year during the period 1965-1970 to reach about 1,103,800 at the beginning of the plan (see Table XII). During the plan period. The labor force increased by 10 percent per year. The number of employees in the manufacturing sector more than doubled, rising from 34,700 workers in 1970 to 74,400 in 1975, which accounts for only 4.2 percent of the total employment. The finance sector is the only sector which experienced a decline in employment during the plan.

Long before implementation of the first plan, the Government recognized manpower shortages as a major bottleneck in achieving objectives of the plan. It places great emphasis on education by allocating to it about 7,377.7 million Saudi Riyal (MSR) or about 17.8 percent of the total financial allocation for the plan. Six vocational training centers would be opened during the plan period which would supply about 1,600 skilled and semiskilled workers [48].

It is very difficult to say that the FDP was a total success or a total failure. The actual rate of growth of the total GDP exceeded the plan target, while that of the agricultural and manufacturing sectors failed to achieve the plan's projected rate of growth of GDP. However, one must keep in mind that the plan was prepared under a tight financial

TABLE XII

EMPLOYMENT BY SECTOR IN SELECTED YEARS
(IN THOUSANDS)

Sector	1965	1970	1975
Producing sectors:			
Agriculture	464.8	445.8	695.0
Mining	11.2	13.7	3.4
Manufacturing	41.0	34.7	74.4
Utility	8.6	12.2	16.1
Construction	104.0	141.5	172.3
Services sectors:			
Trade	95.8	114.3	153.6
Transport	44.0	62.1	114.5
Finance	4.5	15.9	13.1
Services	108.5	137.5	230.0
Government	110.4	112.7	246.7
Oil sector:	14.0	13.4	27.4
TOTAL	1,006.8	1,103.8	1,746.5

Sources: [145, p. 140].
[91, p. 19].
[92, p. 37].

situation. Because of the 1967 Arab-Israeli war, oil revenue declined during the three years prior to FDP. The huge increase in revenue during the plan period could be the main reason for the high rate of growth of the total GDP. This led one to question the feasibility of achieving the plan projected rate of growth if the financial situation of the country did not change. The rate of growth set forth by the plan proved too ambitious in light of the financial and human resource constraints the country faced when the plan was prepared. One must also realize this was the first experience the country had with formal planning. The next section determines how much the country has learned from this first experience.

3.4 The Second Development Plan (SDP) (1975-76 to 1979-80)

In April 1975, the Saudi Government adopted a second five-year development plan for the period 1976-1980. The three major objectives advanced by this plan are:

1. Diversification of the economic base through emphasis on increasing agricultural and industrial production.

2. Speedy development of the kingdom's human resources by providing training to increase their productivity.

3. Distributing the growth in economic activity among all regions in the country [91].

The main objectives of this plan were almost exactly the same as the preceding plan. The difference was that the former plan emphasized diversification by concentrating on all economic activities to reduce dependence on oil, while this plan concentrated only on the agricultural

and manufacturing sectors since the first plan failed to achieve the anticipated rate of growth in the sectors. The Central, Western and Eastern regions were given top priority during the FDP while the Northern and Southwestern regions were left out. The SDP attempted to correct this situation by distributing the country's wealth from oil to cover all regions of the country.

The plan was prepared at a time when the income from oil revenue had increased dramatically which eliminated the financial constraint on development as opposed to the situation of the FDP. The plan's estimated total cost was SR 498 billion which was about nine times that of the FDP. The plan was very ambitious. It was too big with respect to the amount of money expected to be spent during the duration of the plan. However, financial resources are not the only constraint faced by developing countries. Physical and human resource constraints play equally important roles in the success or failure of development in those countries. Planners in Saudi Arabia realized this fact and concentrated on the development of physical infrastructure and human resources by allocating about 64 percent of the total amount of the money appropriated for the plan. This compared to 58 percent in the previous plan (see Table XIII).

The largest amount of funding was allocated to the development of physical infrastructure, which was considered a stumbling block to development. During this plan, about 40,000 new houses were constructed per year compared to 17,500 during the first plan. New seaports were built and old ones were expanded, raising the number of commercial berths to 130 compared to only 24 at the end of the previous plan [92]. During the first half of the plan the major threat to its implementation

TABLE XIII

COMPARISON OF ESTIMATED FINANCIAL REQUIREMENTS OF FIRST AND SECOND PLANS[a] (SR MILLIONS)

	First Plan (1970-1975)		Second Plan (1976-1980)		Ratio: Second Plan to First Plan
	Amount	Percent	Amount	Percent	
Economic-resource Development	6,033.3	10.7	92,135.0	18.5	15.3
Human-resource Development	10,198.7	18.1	80,123.9	16.1	7.9
Social Development	2,443.0	4.4	33,212.8	6.7	13.6
Physical-infrastructure Development	14,086.8	25.1	112,944.6	22.7	8.0
Subtotal (Development)	32,761.8	58.3	318,416.3	63.9	9.7
Administration	10,466.5	18.6	38,179.2	7.7	3.7
Defense	12.994.7	23.1	78,156.5	15.7	6.0
External Assistance, Emergency Funds, Food Subsidies, and General Reserve			63,478.2	12.7	
Subtotal (Other)	23,461.2	41.7	179,813.9	36.1	7.7
Total Plan	56,223.0	100.0	498,230.2	100.0	8.9

[a]First plan values have been adjusted to 1974/75 prices (used uniformly for the second plan except for certain long-term projections that included inflation factors).

Source: [92, p. 529].

was the inability of the physical infrastructure (housing, ports, roads, . . ., etc.) and the difficulty of the country to keep up with the pressure placed on it by the ambitions of the plan. Shortages of housing and commercial berths were very acute during the first half of the plan. Some ships had to wait four to six months before unloading. Those were only a few of the problems encountered during the first half of the plan due to the inadequacy of the physical infrastructure in the country.

Economic resource development (i.e., water, agricultural, manufacturing) had been allocated about 18.5 percent of the total plan appropriation or SR 92,135 million. About 48 percent of this amount or 44,280.6 was allocated to the expansion of the manufacturing sector. At the beginning of the plan, The Royal Commission for Jubail and Yanbu was created by royal decree M175. The two industrial sites emphasized the petrochemical industries which depend on oil for its raw materials. In 1977, the OPEC nations produced more than one-third of the world's oil but only 3.2 percent of the world's petrochemicals derived from it [41]. Saudi Arabia is concentrating on oil related manufacturing industries because the raw material for these types of industries are available in abundant amounts in the country. Non-hydrocarbon-based manufacturing industries such as construction materials, automobiles and parts, fabric, canned foods, and other consumer products were also constructed during the plan to reduce the dependence on importation.

The plan anticipated an annual growth rate in GDP of 10.2 percent. Agriculture and oil were projected to grow at 4.0 and 9.7 percent per year during duration of the plan. They were the only sectors expected to grow less rapidly than the overall rate. The economy failed to achieve the 10.2 percent growth rate, registering instead only 8.04

percent per year. The main reason for the failure was the inability of the oil sector to grow according to the plan projection. Actually, the oil sector grew only by 4.8 percent per year instead of the 9.7 percent anticipated by the plan. All other sectors of the economy achieved higher rate of growth than projected by the plan. The producing sectors and service sectors grew by 16.6 and 14.1 percent per year, respectively, compared to the planned rates of 13.0 and 13.3 percent [92].

This reflects the important role the oil sector plays in shaping the economy of the country. Little changes in the structure of the economy was experienced during the plan (Table XIV). Thi reduces the severity of the assumption of constant technical coefficients of the static input-output model to be discussed in the fourth chapter.

The overall annual rate of growth of the labor force was projected to be about 7.8 percent. The Saudi labor force was projected to increase by 232,000 workers or about 3.4 percent and the non-Saudi workers by 498,000 or about 21 percent per year [91]. The actual annual growth rate of the labor force during the plan was only 7.2 percent. The number of non-Saudi workers increased by 566,000 because the population of the country supplied only an additional 158,000 Saudi workers instead of the required 232,000. The main reason attributed to the failure in attaining the anticipated number of new Saudi workers was the expansion of education which kept more young Saudi out of the labor market (see Chapter II). The largest increases in employment were registered by the professional and salesmen groups, 125 and 72 percent, respectively (see Table XV). Farmer and fisherman occupations experienced a slight decline of 3.7 percent.

TABLE XIV

GROSS DOMESTIC PRODUCTS DURING 1976-1980
(IN CURRENT PRICE IN MILLIONS
SAUDI RIYAL)

	1976	1977	1978	1979	1980
Producing sectors:					
Agriculture	1,586	1,865	3,909	4,196	4,648
Mining	533	823	1,025	1,120	1,361
Manufacturing	2,211	3,063	4,066	5,173	6,467
Utility	151	144	204	248	271
Construction	15,854	25,546	31,959	34,764	43,108
Service sectors:					
Trade	6,180	8,507	11,049	13,912	17,760
Transport	4,077	6,775	9,960	12,764	15,749
Finance	8,444	11,130	12,704	16,180	18,815
Services	1,989	2,609	3,293	4,155	5,260
Government	7,890	9,720	15,146	18,912	23,384
Oil sector:	115,522	134,687	132,064	138,540	251,984

Sources: [111, pp. 169-170].
[112, pp. 92-93].

TABLE XV

EMPLOYMENT BY OCCUPATIONAL GROUPS 1975-1980
(IN THOUSANDS)

Occupation	1975	%	1980	%
Professional[1]	106.7	6.1	240.4	9.7
Clerical Workers	175.0	10.0	231.7	9.4
Salesmen and Laborers[2]	624.8	35.8	1,076.9	43.6
Farmer and Fisherman	646.1	37.6	622.2	25.2
Service Workers	193.9	11.1	300.0	12.1
TOTALS	1,746.6	100.0	2,471.2	100.0

[1]Includes technical, managerial, and administrative workers.
[2]Includes craftsmen, operators, and laborers.

Source: [11, p. 33].

The reliance upon imported labor during the plan was considerable, almost 566,000 new workers during the plan. This lead to the importation of over one and a half million persons into the country.[2] This large number of newcomers will put a great deal of pressure on the already weak service sectors.

Table XVI shows a substantial decline in the agricultural labor force. This is a good trend for a country like Saudi Arabia because of two reasons. First, agriculture is a traditional low productive sector and agriculture laborers are migrating to the cities to work in modern sectors such as construction and industry. The second reason is that women in rural areas are working in the farm alongside the men while their counter-sisters in the city are prohibited to do so. The shortage in agriculture labor due to out-migration of young farmers could be picked up by women and by increasing the productivity of the farmers.

The Government sector absorbed the majority of the Saudi workers which forces the private sector to fill its need of labor by importing it from outside. This fact and the Government's concentration on infrastructural development, demands a fast growth in the construction, transportation, and services sectors which are through-put sectors. This fact leads Seers to modify the original work of Leontief, which gives these sectors a very important role in explaining the inter-dependency among all branches of the economy. Actually, in developing countries the development of these sectors are essential to the development of the whole economy. The Saudi planners realized the important role these sectors can play in speeding the goal of diversification of

---

[2]That is, if each imported worker brings his wife and one child.

TABLE XVI

EMPLOYMENT BY ECONOMIC ACTIVITY 1976-1980
(IN THOUSANDS)

	1976	1977	1978	1979	1980
Producing sectors:					
Agriculture	675.8	656.6	637.3	618.0	598.8
Mining	4.0	4.6	5.4	6.3	7.3
Manufacturing	78.9	83.2	88.6	93.9	104.2
Utilities	18.5	21.2	24.3	27.9	31.5
Construction	196.4	223.9	255.3	291.0	330.1
Services sectors:					
Trade	178.1	205.8	238.7	275.7	310.6
Transport	129.9	146.9	165.9	188.4	214.6
Finance	15.9	19.4	23.7	28.7	34.8
Services	266.8	308.1	357.5	414.7	482.3
Government	260.0	274.1	288.9	304.5	321.0
Oil sector:	28.9	30.6	32.4	34.2	36.0
TOTAL	1,853.2	1,974.4	2,118.0	2,283.3	2,471.2

Source: [92, p. 37].

the economy. They place great emphasis on the development of those sectors. Those sectors by no means will offer long-term potential alternatives to oil. Agriculture and manufacturing are the major sector which have the potential for diversifying the Saudi Arabian economy and decreasing its dependence on oil as the main source of revenue.

Substantial progress was achieved during the duration of the plans and to the attainment of the plan objectives. Favorable growth rates were attained by the non-oil sectors, absorptive capacity of the economy was increased, tremendous improvements in the physical infra-structure were achieved despite the difficulty encountered during the first half of the plan, and a good industrial base was established in this period. Shortage of manpower continued as the major constraint in the development of the country. The third development plan was concerned with increasing the productivity of workers through training, thus reducing the reliance on foreign workers.

3.5 The Third Development Plan TDP (1980 to 1985)

The first two development plans focused on the building of infra-structure, services, achievement of high rate of growths in all sectors of the economy, and reliance on imported workers. In May 1980, the third development plan was approved. This plan differs from its predecessors in the following: it concentrates on a few selective sectors--agriculture, mining, and manufacturing; it limits the future growth of the total number of foreign workers; and meets the country's labor demand domestically by emphasizing capital intensive industries and maximizing the utilization of domestic labor. The major objectives of this plan

are:

1. Structural change of the economy. In other words, reduce the dependency on oil.

2. Participation and social welfare in development.

3. Economic and administrative efficiency [92].

The third plan presents a shift in the direction of planned development expenditures (see Table XVII). It concentrates on the development of the producing sectors rather than the old path of concentration on physical infrastructure. The share of physical infrastructure and social development of the total expected Government expenditure will drop from about 50 and 10 percent during the SDP to 36 and 9 percent, respectively, during the TDP. While the share of economic and human resources development will increase from 25 and 16 percent to 37 and 19 percent, respectively over the same period.

The anticipated annual rate of growth of GDP during the plan is 3.28 percent, with non-oil sectors projected to grow by 6.19 percent while the oil sector is projected to grow by only 1.34 percent (see Table XVIII). The low rate of growth projected during the plan is attributed mainly to two reasons. First, the anticipated low increase in the number of additional workers during the plan; and, secondly, to the drying up of labor migration from the low productive sector, agriculture, to the high productive sectors of construction and manufacturing. The construction sector is anticipated to decline by 2.48 percent per year during the plan. However, the first two years of this plan experienced a growth in this sector due not to the initiation of new projects but to the completion of projects started in the second plan. Actually, the construction sector registered an increase of over 10

TABLE XVII

TOTAL GOVERNMENT EXPENDITURE ON DEVELOPMENT
1980-1985[1]

Function of Expenditure	SR Billions Current Prices	2nd Plan[2] Percent	3rd Plan Percent
Economic Resource Development	261.8	25.1	37.3
Human Resource Development	129.6	15.9	18.5
Social Development	61.2	9.4	8.7
Physical Infrastructure	249.1	49.6	35.5
Subtotal: Development	701.7	100.0	100.0
Administration[3]	31.4	6.7	4.5
Emergency Reserves, Subsidies	49.6	15.9	7.1
Total Civilian Expenditure	782,6	122.6	111.6

[1]The total excludes: (i) transfer payments, (ii) non-civilian sectors, and (iii) foreign aid.

[2]Based on actual and estimated values converted into 1399/1400 prices.

[3]Administration includes: (i) ministries and agencies with primarily administrative functions and (ii) judicial and religious agencies.

Source: [92, p. 88].

TABLE XVIII

THE GROWTH OF GDP IN THE PERIOD 1966-67 TO 1984-85 (ANNUAL COMPOUND GROWTH IN PERCENT PER ANNUM, IN 1969-70 PRICES)

	1966-67 to 1969-70	First Plan 1969-70 to 1974-75	Second Plan[a] 1974-75 to 1979-80	Third Plan 1980-81 to 1984-85
Producing sectors:				
Agriculture	3.62	3.59	5.40	5.35
Other mining	5.56	21.07	17.14	9.78
Other manufacturing	11.76	11.39	15.37	18.83
Utilities	11.31	10.93	24.41	29.46
Construction	3.32	18.57	17.78	(2.48)[b]
Service sectors:				
Trade	10.09	13.94	22.06	8.42
Transport	10.58	16.97	21.13	12.93
Finance	7.94	8.16	12.99	7.29
Other Services	9.76	7.09	13.91	2.95
Government	4.39	7.75	5.96	7.16
Non-oil economy:	6.96	11.66	15.13	6.19
Oil sector:	10.34	14.80	4.78	1.34
Total economy:	8.75	13.41	8.04	3.28

Notes: a. Sectoral data for the First Plan period shown above include the old price system for 1974/5; the Second and the Third Plan figures, however, use the revised price system for each sector. Tables for the non-oil economy, the oil sector and the total economy for the Second and third plans are in 1979/80 prices, partly because the 1984/5 composition of the oil sector's output has no equivalent in 1960/70. b. Negative growth rate.

Source: [92, p. 20].

percent during the first two years of the plan while the non-oil sectors registered about 11 and 10 percent increase during the same period respectively [7].

Domestic manpower development is the major objective of the TDP because optimum utilization of this scarce resource is the key element to the success of the plan. The plan attempts to reduce the reliance on foreign workers. It encourages the redeployment of workers away from the remote areas and the less productive sectors into high productive sectors of the economy. The plan projected an annual increase of 1.2 percent in the growth rate of the country's labor force during the TDP period (see Table XIX). Agriculture and construction are the only sectors which will experience a decline in the labor force. The reason for the decline in employment in the agriculture sector was discussed early. The reason for the decline in construction is that the first two plans, FDP and SDP, required the upgrading of the physical infrastructure of the country which is mainly related to the construction sector while the third plan emphasized maintaining of the physical facilities built in the past decade. The manpower needed to maintain those facilities will be far less than that needed to build then. Based on this, excess labor in the construction sector will begin to look for positions in the other economic sectors.

The plan will create 310,000 new civilian employment opportunities. Of these, 70,000 will be filled by workers leaving the construction sector [17]. The remaining 155,000 jobs will be filled by 146,000 new Saudi workers entering the labor market for the first time and only 9,000 new imported workers. At the end of the plan duration, the imported labors will account for 41 percent of the total labor force instead of the 43 percent at the end of the SDP. This indicates that

TABLE XIX

PROJECTED CHANGE IN EMPLOYMENT DURING THE THIRD PLAN (1980-1985)

Sector	Employment in Thousands in 1980	Employment in Thousands in 1985	Annual Percentage Change	Total Percentage Change
Producing sectors:				
Agriculture	598.8	528.8	(2.5)	(11.7)[1]
Mining	7.3	9.8	6.0	34.2
Manufacturing	104.2	164.2	9.5	57.6
Utilities	31.5	47.0	8.1	49.2
Construction	330.1	245.1	(6.0)	(25.7)[1]
Services sectors:				
Trade	310.6	339.6	2.0	9.3
Transport	214.6	274.6	5.0	28.0
Finance	34.8	44.8	5.0	28.7
Services	482.3	505.3	1.0	4.8
Government[2]	321.0[3]	421.0[3]	5.6	31.2
Oil sector:	36.0	46	5.0	27.8
TOTAL	2,471.2	2,626.2	1.2	6.3

[1]It is a decline in its percentage.

[2]Excludes non-civilian employment.

[3]These government figures include an estimated 49.6 thousand daily wage workers, not classified as civil servants.

Source: [92, p. 100].

the country will be dependent on imported labors for a long period to come. The low participation of women will not help the situation. The plan anticipates about 17,000 new Saudi women workers will join the labor force during the plan period. This is a small number when compared to the overall increase of about 155,000 new workers. The majority of the new female workers will join the labor force as teachers or in jobs related to teaching. Very few will be in the health sector as physicians or lab technicians. The advantage of this increase will be offset in the short run by the fact that the number of female farmers will decrease due to the schooling factors. The schooling factor will also effect the participation rate of young Saudis in the labor force. The male participation rate will decline from 65.3 percent at the end of the SDP to 64.1 percent over the duration of the TDP. This might seem a negative trend, but in fact, it is a good sign which indicates public awareness about the need for education.

The TDP is very ambitious but not unrealistic. The current oil situation raises doubt in the mind of a lot of people about the destiny of this plan. Their doubt arises from the fact that the plan was formulated in a favorable economic situation of high demand and increasing oil price. One must realize that the plan was formulated based on a discounted oil price which will offset the effect of price reduction. With respect to oil production, Saudi Arabia produced 9.5 million barrels per day as a goodwill gesture to the industrial nations and the world to pick up the slack created by the Iran-Iraq war. Economic observers indicate that Saudi Arabia does not need to produce 9.5 million b/d to be able to finance its ambitious plan, about 5 million b/d will be more than sufficient [48]. In an interview with the Ministers

of Finance, Planning, and Petroleum, all denied any serious effect on the implementation of this plan due to the world oil situation [6, 7, 8]. The outlook of the fourth development plan, now under study will be examined next.

3.6 An Outlook Into the Fourth Development Plan FODP (1985-1990)

Studies for the preparation of this plan are now underway. The anticipated major objectives of this plan are as follows:

1. Development of the Kingdom's human resources through training to increase productivity.
2. Increase the well-being of the citizens.
3. Continue the diversification of the country's economic base.
4. Maintain the physical infrastructure built during the previous plans.

One can easily detect the similarity of objectives among the development plans. They all aim at diversification of the economy, the development of human resources, and improving the well being of the citizens of the country. What really distinguishes one plan from the other is the degree of achievement of these goals.

The first plan achieved a high rate of capital formation and provided the Saudi planners with a good experience in the field of national planning. The experiences learned from the first plan were wisely utilized during the preparation and implementation of the second plan. The major objective of the SDP was to increase the absorptive capacity of the economy and reduce inflation through the improvement of the physical infrastructure. The second plan succeeded to a certain extent in

achieving the objective of diversification of the economy. The twin industrial cities of Jubail and Yanbu, the Saudi Arabian Basic Industries Corporation (SABIC), and gas gathering program were only a few of the projects started in this plan to reduce the country's dependency on oil. The third plan continued the building of physical infrastructure and diversification of the economy. The major obstacle to the implementation of this plan was manpower. The ceiling put on the importation of laborers placed a tremendous pressure on the domestic laborers to pick up the slack. The fourth plan will witness an increase in the internal output in every sector and a lowering of the cost of the domestic products and services due to improvement in labor productivity, thereby making them competitive and more desirable to consumers than imported products. The development of the mineral deposit in the country will experience increased attention during this plan.

According to Petromin[3] statistics, 12 minerals are found in the country [12]. Seven of those minerals - gold, silver, copper, zinc, lead, ore, and iron are found in large commercial quantities; while the rest - phosphates, salt, magnesium, sulphur, and fluorite, are found in smaller quantities. Gold mining was recently resumed at the old Mohd al DHAHAB mine. The mine is expected to produce 30 tons of gold, 90 tons silver, 80 thousand tons of copper, and 27 thousand tons of zinc by the year 1990 [8]. This indicates that the country is rich in its mineral deposits which will generate a large amount of revenue and reduce the dependence on oil as well as help the process of diversifying the country's economic base.

---

[3]Petromin is an organization established by Royal Decree No. 25 in 1962 to be responsible for the development of petroleum and natural gas and non-fuel mineral resources in the Kingdom.

The physical infrastructure has been substantially improved. The Kingdom enjoys a reputation as one of the world's foremost financial powers. It is with the manpower that the greatest potential for difficulties in implementation of the future plans exist the shortage of manpower was the motive for this research. The next chapter presents a review of input-output techniques utilized in determining the country's need of the human resource.

CHAPTER IV

REVIEW OF LITERATURE

4.1 The Two Main Approaches to Manpower Planning

There is no universally accepted or settled methodology for manpower planning and forecasting. There are two opposing schools of thought, with numerous sub-varieties. Those two schools are the rate of return approach and the manpower-forecasting approach.

4.1.1 The Rate of Return Approach

This approach advises the planner to calculate the internal rate of return on investment in education and to supply just enough schooling to equalize the yield of investment in human capital with the yield of investment in physical capital [21]. The internal rate of return is the social rate of discount which makes the present value of the entire stream of benefits and costs exactly equal zero [94]. Mathematically, the internal rate of return (R) is calculated as:

$$\sum_{t=0}^{n} \frac{B_t - C_t}{(1 + R)^t} = 0 \qquad (4.1)$$

where:

B_t is the social benefit in time t,

C_t is the social cost in time t, and

R is the internal rate of return.

The rate of return has been frequently criticized by researchers in the area of manpower planning to developing countries [9, 21]. Some of those criticisms are:

1. It does not incorporate systematic assessment of linkage between education and economic development over time. By contrast, the manpower requirements approach takes this into account as a major factor as will be seen later.

2. It assumes pure competition in which labor earnings are brought into line with the relative scarcities of people with different skill attributes.

3. It ignores incomes and benefits other than those that accrue directly to the educated individual. In other words, it ignores the indirect economic return.

4. The rate of return analysis at best measures the current payoff from education. What is needed in a country like Saudi Arabia with rapidly expanding educational systems is the rate of return on investment in education based on future returns and not only present returns.

Education in Saudi Arabia is free to the individual, starting from kindergarten through the university. The Government, in fact, pays students to continue their education beyond high school. Recently the Government increased the university student's allowance to about $300 per month. What Saudi Arabian planners need to know is the required number of workers with a specific educational level to accomplish the desired goals set forward by the higher officials. The criticisms mentioned above make the application of the rate of return technique to Saudi Arabia undesirable.

4.1.2 The Manpower Requirement Approach

The manpower-forecasting approach tells the educational planner to tailor the expansion of the educational system to quantitative forecasts of the demand for highly qualified manpower [21]. There are several different methods for forecasting manpower requirements. Two of these are the Tinbergen-Bos model [130] and the Mediterranean Regional Project (MRP) [104]. The technique which will be used in this study is the input-output analysis. This technique forecasts the target year sectoral employment by occupation and education based on the following assumptions:

1. Fixed technical coefficients or stable relationships between employment and output.

2. No substitutability between sectors and perfect substitutability within a sector.

3. Constant labor productivity rate by sector.

This approach has been criticized for ignoring the influence of inter-occupational mobility of labor on future levels of occupational requirements, as well as other rigid assumptions [100].

4.2 Input-Output Approach

4.2.1 Historical Development

An input-output or interindustry analysis can be traced back to the Tableau Economique published in 1758 by Francois Quesnay [33]. Later he published a modified tableau which presented the whole French economy in the form of circular flows. Leon Walrus, who was a skilled mathematician, in 1877 developed a purely theoretical general equilibrium model

which essentially consisted of a set of equations illustrating how all prices in the economic system were determined. He believed that even if the data were available to implement his model, the computational problems would be formidable if not insurmountable.

It was not until Leontief simplified the Walrusian model to a manageable extent in the 1930's that the input-output technique, as it is now known, began to emerge. Leontief ignored prices, and consequently substitution, and assumed that any product was supplied by only one sector and that there was a constant return to scale, making possible the empirical application of input-output models, the first of which was produced for the United States economy in 1936 [74]. The early work of Leontief led to the first governmental research on interindustry analysis in the United States, undertaken by the Bureau of Labor Statistics with Leontief as an advisor. The group undertook from 1950 through 1954 the most extensive program of interindustry research so far attempted [35]. But, due to a decision by the Deputy Secretary of Defense to terminate support of input-output studies after November 1954, this research was cut off abruptly before its completion [82]. There was a period of more than five years during which government agencies in the United States could not engage in such analysis. Despite the cessation of government work, research on interindustry relationships continued at the Harvard Economic Research Project and other universities, largely financed by foundation funds, and also in other countries.

The input-output techniques spread rapidly throughout the world, including the developed and developing countries as well as the communist block. Currently, more than 64 countries have input-output tables [137]. Leontief's publications were widely read in many of these

countries, and their scholars came to the Harvard Economic Research Project to learn how to compile and use input-output tables. The United States, Western Europe, and Japan were the first to assemble the input-output tables for their countries and after various delays, countries with central planning and developing countries followed.

The interest in the technique was sufficient to stimulate an international conference which was held in 1951 in Driebergen, Holland; its program centered on the construction and empirical implementation of the basic theoretical system [127]. The second conference was held in June 1954, in Varenna, Italy. Its program was centered on statistical and computational procedures and problems [16]. The application of the input-output techniques to economic projection and development planning were the dominant topic of the third conference which was held in September 1961, in Geneva [17]. Representatives of the developing countries participated in this conference for the first time. It is no longer true that the usefulness of the input-output technique is restricted to developed countries. A number of developing countries (Egypt, Israel, some Latin American countries) have applied this technique and proved its usefulness in planning the economic development of their countries. The fourth and fifth international conferences were held in Geneva in 1968 and 1971, respectively [26, 27, 24]. The first volume of the fourth conference [26] contains more theoretical studies while the second volume [27] stresses empirical and policy aspects of the model. The fifth conference [24] contained 32 papers, some of which were a continuation of studies presented in the fourth conference. The sixth conference [108] contains both theoretical as well as empirical studies of input-output models. This conference was the first among the

proceedings of the international input-output conferences to include papers describing quarterly input-output models. The work done by Shishido and Oshizaka [118] and Haig and Wood [58] constitute an important breakthrough in this direction.

Three basic versions of the input-output model emerged from the beginning of the mid-thirties to now: the closed static model; the open static model; and, finally, the dynamic open model. Since the closed model was developed first, it is described very briefly and mention is made as to how it differs from the open model.

4.2.2 Static Closed Input-Output Model

The main difference between the closed and open static input-output model is that the closed model considers all economic activities as endogenous or interdependent. So there are no exogenous or final demands and no primary or unproduced inputs, as shall be seen when introducing the open models. Leontief's [75] early work was devoted to this version of the model. In this version of the model, households are treated exactly as any other industry. Households use consumer goods in specific amounts (it is required inputs) to produce its output, labor, which is required by other industries to carry on their production activities. Government and foreign trade are similarly treated as household.

This model, since it attempts to account for all consumption, is called "closed." It is the most ambitious version, since it attempts to explain more than any other model, but also, it requires the most unpalatable assumptions and is the most restrictive since it provides no room for autonomous investment, exogenous changes in government

demand, or the like. For these reasons the general tendency has been away from the closed version of the input-output model toward the open model.

A partial closure of the model may be adopted depending on what portions of final demand become endogenous. The most common closure of the model is to treat household as an endogenous sector [82, 109]. Richardson [109] mentioned another possibility to partially close the model. Paukert, Skolka, and Maton [106] developed a model to study the impact of changes in income distribution on the level of employment for the Phillippines. In their model, they have treated private savings, consumption, personal income, and other income as endogenous elements, and the only exogenous element in the model was the shift in the income distribution by size.

4.2.3 Static Open Input-Output Model

The closed model interdependence was too complete, in view of the available data and the consequent necessity to accept such unrealistic functions as fiscal patterns of consumption, investment, Government activity, and foreign trade, in order that these could be fitted into the equational system. It was necessary to open up the model, making some of the variables independent, as a necessary step toward practical application and the possibility of large new areas of inquiry. Professor Leontief soon realized this fact and worked toward opening the system by introducing some basic modifications. These modifications gave birth to the static open input-output [75].

The static open model is too well known to require detailed elaboration. A few number of excellent concise summaries of Leontief's

basic framework have already been published.[1] A very brief description of the model and a review of the development and criticism of the model is necessary to comprehend the dynamic model.

Basically, the static open model consists of nothing more complicated than the solution to a set of N simultaneous linear equations in N variables. It is a system of equations that define the functional relationships (Table XX): (1) within the processing sectors (quadrant I in), (2) between the processing sectors and final demand (quadrant II), (3) between the processing sectors and primary input (quadrant III), and (4) between this latter class of primary input and their final demand (quadrant IV). Some authors suggested the elimination of the fourth relation or the fourth quadrant of the table [117, 137]. When this system is shown as a set of solution flows during some periods, its variables include:

a. the quantity of each produced good supplied as input to each processing sector,

b. the quantity of each processing sector supplied to final demands,

c. the quantity of each primary input supplied to each processing sector,

d. the quantity of each primary input supplied to final demand,

e. total output of each processing sector,

f. the sum of the various inputs used by each processing sector,

g. the sum of the various inputs used by the final demand, and

---

[1]Those who are interested in the application of the model should read Leontief [77], Chenery and Clark [35], Richardson [109] and the theorist should read Dorfman et al. [45] and Gale [52].

TABLE XX

A CLASSIFICATION OF TRANSACTION

Output / Input	Sector 1 ····· j ····· n	Final Demand	
1 · · · · · i · · · · · n	X_{ij} Quadrant I (Processing Section)	Quadrant II (Final Demand Section)	X_i
	Quadrant III (Final Payments Section)	Quadrant IV (Final Demand-Final Payments Section)	
	X_j Total Gross Input		

h. the sum of the supplies used by the processing sectors and final demand.

In the static open model there are three types of transactors in the system. The first transactor is the processing sectors which use each other's output as well as the primary input in order to produce their output. The second is the primary input which provides their inputs for the processing sector and final demand. The third transactor is the final demand which just consumes goods and the quantities which are consumed by it are not determined within the model, but must be specified as parameters.

In an input-output table the total value of output of each producing sector is always equal to the total input by that sector. For the final demand sectors and the primary input sectors, this situation may not hold. Here the equality of any particular sector in the final demand with any sector in primary input is not logically necessary or factually probable, even where the titles of the final demand sector and that of the primary input sector specify a common set of transactors. For example, the import sector in primary input may or may not be equal to the export sector in final demand. But, total final demand must equal total primary input for each processing sector.

If final demands are projected outside the Leontief model, then the projected final demands are incorporated into the model to project total output. This and the assumption of the model raised several objections about the technological postulate of the model. For a complete discussion of those assumptions, see Dorfman [44] or Christ [37].

4.2.4 Remarks About the Application of the Technique to Saudi Arabia

The usefulness of constructing an input-output table in advanced economies ceased to be a topic of argument. Researchers had stopped criticizing Leontief's model and joined his bandwagon in developing the techniques and making it more practical. This is very obvious from the amount of literature which has been written about the subject and the numbers of countries which are trying to develop a model for their planning purposes. According to Chenery and Clark [35], in 1959 there were only 19 countries with an input-output table. Today the number of developing countries with an input-output table exceeds this number.

The usefulness of input-output for a developing economy has been questioned by researchers, especially those who have tried to develop a table for some highly underdeveloped countries in Africa [107]. They based their argument on two factors. First, there is a lack of statistics useful for the construction of the flow table. This is not the case in Saudi Arabia. The central statistical department was established in 1960 and the first development plan for the country for the five-year period 1970-71 to 1974-75 was submitted to the Council of Ministries on August 16, 1970. Now the country is working on implementing its third development plan 1980-81 to 1984-85, and studies are under way to steer the Kingdom toward the 1990's. In the case of Saudi Arabia, it may be wiser to say that the data needed is available but dispersed, rather than scarce. The lack of reliable statistics should by no means be a hindrance, and the construction of the model should not automatically be stamped on this account as a useless tool of analysis and projection. In fact, the postponement of constructing such a model

may lead to the postponement of a serious review of the gaps in the data and their processing [47].

The second reason is that there appears to be very little interdependence between the different sectors of the economy in a highly underdeveloped economy. This argument is based on tables prepared by Seer's for the Gold Coast [116] and on Peacock and Dosser [107] experiences with input-output work in Tanganyika as an example of the lack of interdependence.

The lack of interdependence represents a very strong argument against the construction of an input-output table. But in underdeveloped countries, the relationships between the various sectors of the economy are very important to planners. To develop the economy of the country, the planners need to know which sector of the economy holds the key to rapid growth. It is well-known that an input-output table is not merely a device for storing information. It is, above all, an analytical tool to be used by the planner in analyzing the economic structures of the economy.

It is obvious that the dissatisfaction with the utilization of input-output techniques is meant for those countries with a highly primitive economy and not for developing countries. Saudi Arabia's economy is a unique economy, while the country is a developing country, its economy is markedly different from any other major economy, especially those of the developing countries. Most developing countries are characterized by:

1. A large agricultural sector which is based mainly on subsistence farming--the agricultural sector of Saudi Arabia accounted for about 1.00 percent of total GDP in 1974-75 [91]. The economy of Saudi

before the discovery of oil in 1932 was based solely on agriculture. But the discovery of oil has brought with it a change in the structure of the economy of the country. Farmers are giving up farming to go to the city for higher wages or to join an oil company like ARAMCO. This situation to a certain extent resembles the industrial revolution in the United States.

2. A high rate of population growth--in 1962, the population grew at about 1.5 percent [144]. Currently the population growth is about 3 percent. This is not a high percentage when it is compared to some of the other developing countries like India and Egypt.

3. A high level of unemployment--this is not the case in Saudi Arabia at all. As a matter of fact, Saudi Arabia today depends on foreign workers because the domestic supply of laborers is unable to provide the numbers required of the skilled, semiskilled, or unskilled workers.

4. A very slowly increasing manufacturing sector--the contribution of the manufacturing sector to total GDP in Saudi Arabia increased from SR 431 million in 1970 to SR 6467 million in 1980 (see Table XXI). This corresponds to 28 percent annual increase during the past decade. The oil sector accounts for 54 and 67 percent of the total GDP in 1970 and 1980, respectively, while the agriculture sector accounts for only 6 and 1 percent over the same period. This makes the economy of Saudi Arabia different than most of the developing countries in which agriculture is the base for GDP.

Chenery [34] wrote that:

> . . . without disputing the conclusions of Peacock and Dosser as to the limited usefulness of input-output analysis in primitive economies like Tanganyika, it can be asserted that the industrial sectors become much more interdependent as income level rises and that interindustry analysis may be quite important for countries having per capita incomes of $200-$300, or even lower in the case of large countries like India or Pakistan [p.14].

TABLE XXI

GROSS DOMESTIC PRODUCT IN 1970 AND 1980 [IN CURRENT PRICES IN MILLION SAUDI RIYAL]

Sector	1970	1980
Agriculture	984	4,648
Oil	9,347	254,984
Mining	47	1,361
Manufacturing	431	6,467
Utility	273	271
Construction	934	43,108
Trade	1,008	17,760
Transport	1,016	18,815
Finance	1,243	15,749
Services	238	5,260
Government	1,679	23,384

Source: [92, p. 75].

Ghosh [53], a long time associate with the utilization of input-output to the economic development in India, a developing country, wrote that:

> All this does not mean that the input-output technique should be put on the shelf by the planners, in a developing country, in the initial stages of planning. There is a way out. In the absence of reliable statistical data regarding inputs, outputs and capital stocks of different industries we have to resort to what is called in statistical economies "the first order approximation method". In other words, we have to assume that for every industry inputs are proportional to outputs [p. 17].

4.2.5 Dynamic Input-Output Model

The dynamic input-output model grows out of the static input-output model by extracting capital formation from final demands and introducing the accelerator principle. Final demand has to be redefined for this model to include only consumer goods, export, and Government expenditures, etc., excluding capital formation and capital goods. By extracting the column of capital formation from final demand and transferring it to a matrix which will show a record of the sales of capital goods by industries in the rows to the purchasing industries in the columns, one can link the growth in output and investment in a future year. By doing this, one will be able to provide estimates of output levels for only one future year [137]. This method falls short of the fully dynamic model which is able to provide estimates of output levels for a series of future years and to trace the development of the economy from the base year to the target year in such a way that it becomes possible to optimize the pattern of future growth, given some objective functions, rather than focusing attention solely on the final year of the target period.

Due to the limitation of the basic input-output model and its inability to predict outcomes over a fairly long period, at least three dynamic extensions of this basic model are proposed to overcome part of its limitation. The first type of model is based on the assumption that the output of a sector in any period is related to the output of other sectors in previous periods. This type of model has been developed by Solow [121] and, as by-products to other works, by Goodwin [56] and Chipman [36]. Solow in his model relies on an equilibrium argument: because most commodities must be output before they could be used as input in other transactions, supplies, and demands will not be equal unless the various sectors expand and contract in an equilibrium sequence. Goodwin and Chipman use expenditure considerations; increases in the output of any sectors generate income flows which shows up as increases in the demand for other sectors in later periods.

The second type of model is developed by an Air Force group headed by Holley [51, 62]. The model is based mainly on two assumptions. The first assumption is that installed capacity must at all times be at least equal to productive requirements. The second assumption is that no capacity should be installed before its product is required.

The third and most important type is the model developed by Hawkins [60] and Leontief [76]. Both models employ the acceleration principle to explain investment in each sector. The idea of the acceleration principle is that net investment in any sector is proportional to the rate of change of output of that sector. Clark [38] wrote that:

> The essential assumption of the principle in its pure form is that the firm must maintain for technological reasons a fixed ratio between its output and its stock of capital equipment. It follows from this assumption that the firm must undertake changes in its stock of capital equipment, i.e. must undertake net investment, in accordance with changes in its output [p. 243].

These models gave some insight into the nature of dynamic sequences and provided a starting point for more realistic analysis. Leontief in his model assumed that the net capital formation be nonnegative, so that disinvestment (what Leontief called "irreversibility") of capital is ruled out for the economy as a whole, and there is no existence of excess capacity in various time periods. He also tried to avoid the problem of fixed optimization by assuming fixed coefficients of production with only one way of producing each output.

These assumptions of the dynamic model draw a frequent criticism from the researchers in this area. To relax the assumption that no excess capacity exists in various time periods, the dynamic input-output model has to be transformed into a more complex linear programming model. In such a model, Dorfman and others departed from the Leontief approach when it came to the equality matter and use inequality to allow for the existence of excess capacity. Their objective function consists of capital stock. Their reasoning was that capital stock is the only scarce resource so it could be considered as a cost. Dantzig [43] tried to incorporate substitution into the Leontief model by means of linear programming. He used what he called the triangular block Leontief Matrix.

As we see from the discussion above, the dynamic input-output model as originally developed by Leontief is very rigid in its assumptions to cope with all the multiple aspects of economic growth. However, Leontief's input-output technique has set the base for researchers and practitioners to use their ingenuity in developing the model further and making it more applicable. Since the development of the open model in the 1930's and the dynamic model in the 1950's, researchers in both

developed and developing countries are working to improve and to make the technique applicable to their particular needs. Development of the technique has gone basically in two directions--first, theoretical, which will be touched on very briefly; and, second, practical, which will be explored in some detail.

4.2.6 The Theoretical Development of the Technique

The theoretical approach is to design more and more sophisticated tools which cannot be put to use in real life in their present form, but which, with more refinement and adjustment, might become practical in the future. The most advanced, from the standpoint of usefulness of economic policy is the Turnpike Theorem. The credit for the initial inspiration of the Turnpike Theorem goes to Dorfman, Samuelson, and Solow. The theorem is phrased by Tsukui and Murakami [132] as:

> The essence of the turnpike theory may be phrased in the following way. When a balanced growth path of outputs (or capital stocks) which is called the turnpike is uniquely determined in a closed reproduction system, any optimal path of outputs (or capital stocks), which starts from any initial point and attains an optimal accumulation of capital at the final period T, has the following properties.
>
> (a) If T is sufficiently large, any optimal path stays outside of a properly selected neighborhood of the turnpike no longer than a certain definite number N of periods defined independently of T, so that the following must hold in the limit:
>
> $$\lim_{T\to\infty} \frac{T - N}{T} = 1. \qquad (4.2)$$
>
> (b) Any optimal path remains consecutively in the neighborhood of the turnpike except for certain periods at the beginning and at the end of the planning horizon [p.4].

Tsukui and Murakami had developed a series of models for the case of the Japanese economy based on the input-output model and the turnpike theorem. The earlier development of this model could be traced through Tsukui and Murakami's [131, 96] numerous publications as well as the publications of others [25, 65].

The other theoretical approach is the attempt by economists as well as others to combine linear programming and input-output. In the late 1940's, after the appearance of linear programming, economists were the first to recognize the similarity of an input-output model to the constraints in a linear programming problem. They also saw that linear programming could be used to eliminate from the input-output model some of its restrictions. This triggered a wide range of research in an attempt to combine those techniques. Dorfman, Samuelson, and Solow [45], Chenery [35], Hadley [57], and Carter [28] have suggested the use of labor minimization as an objective function. Dantzig [43], as mentioned earlier, tried to incorporate substitution into the Leontief model by means of linear programming. Carter in her linear programming approach to dynamic input-output assumed that total investment during the duration of the study is a major constraint factor. She tried to select the combination of activity level, with new and old techniques that minimize total labor cost. Several theoretical models for economics developed in India have been developed by Ghosh [54]. All the models have a basically similar framework and the main approach in these models is the combination of linear programming and input-output analysis.

The drawbacks of these attempts were mainly the subjective determination of the objective function, the restriction to select only one

target (while economic policy makers must deal with multiple economic goals), and an unclear economic interrelation of their dual solution. In this very limited review of literature, an attempt to combine goal programming with an input-output technique could not be founded. Goal programming instead of linear programming might eliminate the drawback of a single target. It could be a good research topic. An attempt by Ivanov [65] to combine input-output with dynamic programming was very interesting. He used states and basic sequences to analyze the optimization problem for the models, then the characteristics describing the economy (labor limitation, delay in formation of fixed assets, etc.) were added.

4.2.7 The Practical Application of the Techniques

The second direction of the development of the techniques was less abstract and more practical. One of the pioneering contributions in this direction was the Cambridge growth model [124]. The model could be summarized as the presentation and examination of feasible alternatives regarding the future of the economy. The model never intended to be a forecast of what is most likely or a statement of what is most desired, but rather attempts to follow through in detail the consequences of particular sets of assumptions [124]. Another model, developed by Barker [15], is used to project alternative structures of the British economy. The model is a combination of technical relationships explaining current and capital transactions and behavioral relationships explaining consumption, foreign traits and prices. The model is similar to those developed for Norway by Johnson and Schreienr [70, 114] and for the United States by Alman and others [5].

The Norwegian model emphasizes the problem of long-term development of the economy where the British model emphasizes the problems of economic policy in controlling the medium-term future. The American model [Inforum] on the other hand is designed to give a comprehensive yet detailed year-by-year forecast of the economy over a period of twelve years, from 1973-1985. The performance of the model was tested by simulating the period 1966-1971. The American model differs from the British in that it emphasizes the dynamic adjustment between investment and output.

Similar studies done in the U.S.A., Great Britain, and Norway have also been carried out for several other countries like Japan [103], Canada [22], Puerto Rico [142], France, Finland, Hungary, the U.S.S.R., and others.

All those dynamic models are very similar in their general framework. This might be a sign for an upcoming standard input-output model. The models mentioned above either produce an input-output table for each year during the duration of the study or for only the final year of the study. The capital coefficient matrices in those models play the role of linking the input-output tables for the different years during the study period.

The practical applications of input-output techniques at the national level could be divided into two categories. The first is the traditional way which has been used in three main areas. The first area is the structural analysis of an economy. The studies of the effect of an individual industry upon the whole economy are the most common kind of structural analysis [35]. Other applications in this field might involve changing the level of imports or exports [115]. This study of

the impact of government decision on restricting or lifting the bound on some import or export commodities is very important to developing countries. Perhaps the most important application has been the use of the Leontief inverse to study the structure of final demands and primary input factors [75].

2 The second is the use of input-output as a forecasting technique. This area is very closely related to the structural analyses described above because the forecasting techniques depend completely on the Leontief inverse, whether one is working with the static or dynamic model and a set of projected final demand. But this area differs from the structural analysis in that final demand in the former are projected outside the input-output model. Its projection is completely independent of the other components in the system. In the structural analysis area the effect of only one unit of final demand was studied whereas in the forecasting techniques the change in all final demands were studied.

The literature contains quite a number of overall economic projections. The first major study was that done for the United States by Evans and Hoffenberg [49], which examined the implications of post-war full employment. The most recent study is the one conducted by Alman, Buckler, Horwitz, and Reimbold [5], also for the United States, which was designed to give a comprehensive yet detailed year-by-year forecast of the American economy over the period from 1973-1985. In 1953, Berman [19] prepared a set of projections to 1975, illustrating various patterns of expansion of consumption, investment, or defense expenditures. The use of the input-output as a forecasting technique has been used by other developed and developing countries. In the Netherlands, Van den Beld [141] has studied the prospective long-term development in the Dutch

economy with an interindustry model. The United Nations economic commissioner for Latin America has made interindustry projections for Columbia [134] and Argentina [135], with an emphasis on the import repercussions of industrial development.

(3) The third traditional application involves international comparisons. Chenery and Watanabe [32] indicated that there could be similarities in production and use of intermediate products among developed countries such as Italy (1950), Japan (1951), Norway (1950), and the United States (1947), even though there exists a wide difference among their resource involvements, per capita income, and the level of dependence on foreign trade. Simpson and Tsukui [119] demonstrated that the economic systems of Japan and the United States, although superficially dissimilar, contain almost identical patterns of industries which are strongly interrelated. In a study by Long [80], he used input-output to compare the economic structure of the United States, a free economy, with that of the Soviet, a planned economy. He showed that there is a considerable amount of similarity between the two economies as well as some meaningful differences that exist. He attributed those differences to the different types of economy of the two countries, different goals and other differences. In recent studies by Santhanam and Patil [110], it has been shown that the production structure of India, a developing country, resembles those of developed countries (Italy, Japan, Norway, and U.S.A.). Laumas' [72] study was devoted to comparison among developing countries (Taiwan, Ceylon, Korea, and Malaysia) and the determination of the key sectors in these countries. To accomplish his objective of a fair comparison among those countries, he aggregated their table into 23 x 23 matrices. All of the countries which Laumas compared are

small developing countries of Asia with low per capita income, a weak industrial base and a very dominant agriculture base. A more recent study of Song [122] confirms the finding of Santhanam and Patil. Song compared the production structure of India and Korea (developing countries) to that of Italy, Norway, and the U.S.A. (developed countries). Song concluded that similarities exist in spite of very great differences in the level of per capita income, natural resource endowment, size of domestic market and relative factor prices.

Those findings lead one to believe that the production structures are similar, not only among developed countries, but also among developed and developing countries. The production structures of the developing countries are also similar. It may be safe to say that the similarity among the economic production structures of the developed and developing countries weakens when the countries concerned have different types of economies.

The second category contains the most recent application of input-output techniques at the national level. The first application which will be considered is the extension of the input-output model to include environmental and ecological issues. It was dealt with for the first time at the international symposium on environmental disruption in a paper by Leontief [78], and later in a paper by Leontief and Ford [79] at the fifth international input-output conference. The authors show how pollution as a by-product of the processing sector can be incorporated into the conventional input-output picture of the whole economy. As is the case in any new development, the approach has been criticized by a number of authors [51, 123]. But the continuing concern about environment confirms the importance of analyzing basic relationships

between economic activity, waste generation, waste treatment, and environmental quality. Recently, Cumberland and Stram [42] developed a more - comprehensive model for the United States. Hartog and Houweling [59] developed a model for Netherlands in which they used Leontief and Ford's model as a point of departure in the development of this model. The model which they constructed differs from that developed by Leontief and Ford in that the "polluter pays" principle is introduced into the input-output framework.[2]

The second application in the second category is the extention of input-output to the problems of planning in general and educational planning in specific. Smith and Morrison [120] indicated that input-output models are essential for economic planning at the national level, and the failure of such plans is often more the result of erroneous assumptions fed to the model's exogenously rather than inherent weakness in the models themselves. The planners should make a detailed study of the interdependency of economic activities, using an input-output flow table, because such a study immensely facilitates planning. The usefulness of input-output as a planning tool differs according to the nature of the economy where it is being used. In a centrally planned economy, it enables the authorities to plan production accurately at the level of the industry and by correctly phasing investment, to ensure optimum utilization of capacity and resources. In a capitalistic economy, this is not possible, because decisions on production are made by the firms

---

[2]The polluter pays principle provides advice to include in the I/O matrix not only the column coefficients or input requirements of pollution-abatement activities, but also row coefficients of those sectors representing the inputs "purchased" by other sectors to abate pollution generation directly by those sectors.

and not the Government. However, a plan based on an input-output model will help to ensure that these decisions will all be made within the same framework of growth rate [136].

It is obvious that the central government should get involved in input-output studies, because of the resources available to them and their need for the flow table. Chenery and Clark [35] indicated that government involvement has a number of advantages as well as disadvantages. The main advantage is to point out weaknesses in existing statistics which only the government is in a position to remedy. On the disadvantage side, the government is most interested in the immediate applications of the model rather than on the methodological development and testing of hypotheses.

The application of the method as planning techniques in the developing countries and many of the socialist economies of East Europe and the U.S.S.R. have enjoyed a phenomenal growth. Mycielski and Trzeciakawski [97] developed a very rigorous mathematical technique to the solution of economic problems in socialist countries. There is a compromise between input-output analysis and the programming techniques. Clark and Taylor [39] also used a compensation of input-output and linear program to set development targets for 1975 and 1980 in Chile using 1970 as a base year.

In a study by Thonstad and Kobberstad [128] in Norway, an input-output model was used to estimate the requirements for manpower with a particular education. In order to estimate the educated manpower requirement, they derived relationships between the output of the industries and their use of different types of educated manpower. Stone [125] illustrated the flexibility of the input-output approach, at the

same time provided a framework which could be used to integrate demographic, educational, and manpower statistics. He showed how the links between the educational and the economic systems could be elaborated to provide better estimates of the resources needed from the production sector by education. Benard [18] presented a dynamic linear programming model which optimized the resources devoted to education with respect to the rest of the market economy. His objective function was to maximize a subjective index of national social welfare. Benard's model required some very rigid assumptions and it is more complicated than its predecessors.

CHAPTER V

THE INTERINDUSTRY AND HUMAN RESOURCE ACCOUNTS

This chapter deals with the development of the interindustry and human resources accounts for Saudi Arabia. The data base needed for implementation of the models presented in Chapter VII are developed. The first part of the chapter deals with development of the interindustry account. The second part of the chapter concentrates on the construction of the human resource account.

5.1 The Interindustry Account

The development of this account is accomplished in the form of three tables. Those tables are: (1) the transaction or interindustry flow table, (2) the direct coefficients table, and (3) the direct and indirect coefficient table. The second table is derived from the first table and the third table is derived from the second table. It is actually a chain of tables, the development of the last table depends on the development of the one immediately preceding it.

Before an attempt can be made to develop this account, two important decisions must be made. Those decisions are: (1) the choice of a base year and (2) the number of sectors in the account. The year 1976 was chosen as the base year because the first and only input-output table for Saudi Arabia was developed for this year by the Ministry of Planning (MOP) [1]. The criteria used in aggregating the economy of

Saudi Arabia into a workable number of sectors are: the significance of the sector in the overall economy of Saudi Arabia and their consistency with available data as classified by the Central Department of Statistics (CDS) and the Ministry of Planning (MOP). The CDS classified the economy of the country into 12 sectors while the MOP used a 26 sector input-output classification. Both types of classification are shown in Appendix A. Unfortunately neither classification could be used. The MOP classification is very disaggregated, and data with respect to labor and economic activities consistent with this classification were not available. The CDS classification is aggregated but future as well as past data with regard to labor consistent with this classification are available in Government publications and international publications.[1] The main reason that the CDS classification could not be used is because there is no input-output table with this classification. Because of the above reasons an attempt was made to aggregate the MOP input-output table to fit that of the CDS classification. Unfortunately, this could not be achieved because the petroleum refining sector and the crude oil and natural gas sector in the CDS classification were aggregated into one sector in the MOP classification. The sectoral classification of the economy used in this research is shown in Table XXII. This classification follows closely the international standard industrial classification (I.S.I.C.) (see Appendix A).

---

[1]Some of the Government publications are: National Account of Saudi Arabia (NASA), MOP, and CDS. Some of the international publications are: International Financial Statistic, and United Nations Yearbook of National Account Statistic.

TABLE XXII

ECONOMIC ACTIVITY SECTOR FOR SAUDI ARABIA

Endogenous Sectors
1. Agriculture
2. Oil
3. Mining
4. Manufacturing
5. Utility
6. Construction
7. Trade
8. Transport
9. Finance
10. Services
Exogenous (Final Demand) Sectors
11. Private Consumption
12. Government Consumption
13. Capital Formation
14. Export

5.1.1 The Transactions Table

The transactions table or the interindustry flow table is the base of the interindustry account, and other tables are derived directly from it. It includes all of the goods and services produced in the economy. Each sector purchases a variety of intermediate goods and services from its own sector and other sectors for the purpose of processing, and at the same time, sells its output to various sectors. Each element in this table represents the amount purchased by the column sector and sold by the row sector. The first quadrant of this table is shown in Table XXIII. This table has been derived by the Ching-Han Fei method of aggregation from the table developed by the MOP in 1978 [50].

The method of reading this table is simple. Each sector appears twice in the table, as a producer and seller of output, row heading sector, and as a user and purchaser of input, column heading sector. For example, the transport sector is shown as a heading for row 8 and column 8. The transport sector purchases about SR 9,486.2 worth of goods from the agriculture sector, SR 321,093.48 worth of goods from the oil sector, SR 1,868.49 worth of goods from the mining sector, . . ., etc. On the other hand, it sells nothing to the agriculture sector, SR 1,122,677.36 to the oil sector, SR 92,098.42 to the mining sector, . . ., etc. The input and output structure of all other sectors can be determined the same way.

5.1.2 Direct Coefficients

After presenting the first quadrant of the transactions table, which is the statistical base of the input-output model, the next step is to derive the unit cost structure or the direct coefficient matrix (A_1). This matrix is shown in Table XXIV. The numbers in the table are

TABLE XXIII

FIRST QUADRANT OF THE TRANSACTION TABLE, 1976
(IN THOUSANDS OF SAUDI RIYAL)

Sector	Agri-culture	Oil	Mining	Manu-facturing	Utility	Construction	Trade	Transport	Finance	Services
Agriculture	9,580.94	0.0	0.0	261.23	0.0	372.97	13,748.19	9,486.20	0.0	0.0
Oil	31,400.74	406,247.17	8,557.57	36,049.09	44,007.08	229,748.28	465,355.37	321,093.48	16,063.03	68,314.20
Mining	0.0	79,860.55	383,752.71	31,521.18	1,646.86	1,538,492.95	2,707.98	1,868.49	952.89	1,115.84
Manufacturing	10,384.50	325,807.91	116,851.26	404,550.89	29,425.30	764,957.35	285,795.69	197,197.97	13,884.99	67,363.67
Utility	0.0	61,920.86	35,512.53	37,442.29	6,205.71	93,614.97	52,284.78	36,076.30	14,157.24	26,449.54
Construction	0.0	88,541.05	1,226.49	158,128.37	14,090.99	1,730,571.47	2,057,229.03	1,419,480.40	63,707.59	19,795.83
Trade	47,533.80	28,356.28	98,428.00	581,226.25	77,871.26	1,023,051.19	771,356.73	532,233.28	43,696.88	140,513.17
Transport	0.0	1,122,677.36	92,098.42	181,551.57	113,633.14	654,185.85	1,304,828.13	900,326.57	107,948.98	64,801.37
Finance	10,260.87	781,244.55	33,282.54	371,810.65	60,486.55	3,059,829.38	1,016,116.16	701,116.38	175,195.88	175,434.82
Services	0.0	375,576.08	7,944.32	31,869.48	4,569.76	745,935.98	52,701.39	36,363.76	3,947.69	9,216.01

TABLE XXIV

DIRECT COEFFICIENTS MATRIX (A_1), 1976

Sector	Agri-culture	Oil	Mining	Manu-facturing	Utility	Construction	Trade	Transport	Finance	Services
Agriculture	0.00155	0.0	0.0	0.00003	0.0	0.00001	0.0	0.00066	0.0	0.0
Oil	0.00508	0.00702	0.00307	0.00414	0.04035	0.00616	0.00139	0.02234	0.00118	0.01653
Mining	0.0	0.00138	0.13767	0.00362	0.00151	0.04125	0.00007	0.00013	0.00007	0.00027
Manufacturing	0.00168	0.00563	0.04192	0.04646	0.02698	0.02051	0.00206	0.01372	0.00102	0.01630
Utility	0.0	0.00107	0.01274	0.00430	0.00569	0.00251	0.00152	0.00251	0.00104	0.0064
Construction	0.0	0.00153	0.00044	0.01816	0.01292	0.0454	0.00108	0.09876	0.00468	0.00479
Trade	0.00769	0.00049	0.03531	0.06675	0.07140	0.02743	0.01595	0.03703	0.00321	0.03400
Transport	0.0	0.01940	0.03304	0.02085	0.10419	0.01754	0.04074	0.06264	0.00793	0.01568
Finance	0.00166	0.0135	0.01194	0.04270	0.05546	0.08204	0.03067	0.04878	0.01287	0.04245
Services	0.0	0.00649	0.00285	0.00366	0.00419	0.0200	0.00134	0.00253	0.00029	0.00223

obtained by dividing each entry in Table XXIII by the total input x_j of that column sector. Mathematically, it is calculated as

$$a_{ij} = \frac{x_{ij}}{x_j} \quad . \quad . \quad . \qquad (5.1)$$

where

a_{ij} - is the technical coefficient of the row sector i and column sector j of the technical coefficient matrix A_1, where A_1 is 10 x 10 matrix.

x_{ij} - is purchases of j^{th} sector from the i^{th} sector needed to produce the total output of sector j.

x_j - is the total input into sector j.

This coefficients matrix does not record the value of each transaction but the amount purchased per unit of output of the purchasing sector. The coefficients (a_{ij}) indicate input requirements per Saudi Riyal (SR) of output. They will show only the first order effects of changes in final demand. This is why it is called direct or first order coefficient.

An interpretation of the numbers in one column of this table will provide a base for the understanding of the rest of the technical coefficients. For example, if the transport sector, column 9, increases its output by one Saudi Riyal, then this will have a direct effect on the rest of the sectors. This action will increase purchases from industries within this sector. Purchases from the agriculture, mining, utility, and services sectors will experience minor changes. In order for the transport sector to be able to increase its output by one Saudi Riyal, it must purchase about 2 halalhs worth of input from the oil sector, 1 halalh worth of input from the manufacturing sector, 10 halalhs worth of input for the construction sector, and 5 halalhs worth of input

from the finance sector[1]. This indicates that of all sectors the construction sector has the strongest relationship with the transport sector. Trade, finance, and industries within the transport sector also show a large relationship within this sector.

5.1.3 Direct and Indirect Coefficients

The direct and indirect coefficients matrix[2] A_2 is shown in Table XXV. It has been determined as follows:

$$A_2 = (I - A_1)^{-1} \quad . \quad . \quad . \qquad (5.2)$$

where I is 10 x 10 identity matrix.

The direct coefficients matrix A_1 showed only the direct effects of changes in final demand. The coefficients in Table XXV show the direct and indirect or total change in input requirements as a result of one Saudi Riyal change in sector final demand. This table, matrix A_2 is called the Leontief inverse matrix which represents the base for the input-output model by which one can utilize to project the total sectoral output. The estimation of sectoral labor requirement depends on the estimate of the sectoral output as will be seen later in Chapter VII.

The interpretation of the numbers in one column of the direct and indirect coefficients matrix A_2, Table XXV, will provide a base for the understanding of the rest of the coefficients. The direct effect resulted in one Saudi Riyal change in final demand of this sector has

---

[1]Each Saudi Riyal is equal to 100 halalh.

[2]For complete mathematical derivation of this matrix see Appendix A.

TABLE XXV

DIRECT AND INDIRECT COEFFICIENTS (A_2)

Sector	Agri-culture	Oil	Mining	Manu-facturing	Utility	Construction	Trade	Transport	Finance	Services
Agriculture	1.00155	0.00002	0.00004	0.00005	0.00009	0.00003	0.00003	0.00071	0.00001	0.00002
Oil	0.00516	1.00779	0.00567	0.00562	0.04415	0.00769	0.00263	0.02526	0.00151	0.01766
Mining	0.00003	0.00184	1.16024	0.00556	0.00329	0.05048	0.00040	0.00565	0.00038	0.00082
Manufacturing	0.00183	0.00663	0.05248	1.05034	0.03151	0.02558	0.00313	0.01857	0.00142	0.01807
Utility	0.00003	0.00126	0.01536	0.00494	1.00655	0.00365	0.00175	0.00332	0.00112	0.00673
Construction	0.00012	0.00411	0.00674	0.02338	0.02701	1.05232	0.00608	0.11196	0.00597	0.00789
Trade	0.00799	0.00232	0.04844	0.07384	0.08092	0.03447	1.018600	0.04555	0.00402	0.03754
Transport	0.000052	0.02163	0.04637	0.02837	0.11830	0.02492	0.04504	1.07301	0.00908	0.02050
Finance	0.00212	0.01593	0.62177	0.05168	0.06938	0.09190	0.03472	0.06529	1.01427	0.04736
Services	0.00005	0.00666	0.00382	0.00415	0.00512	0.00255	0.00154	0.00328	0.00036	1.00257

been explained in the previous section. The total effects, direct and indirect, are always equal to or greater than the direct effect. For illustrative purposes, consider the transport sector, column 8. One Saudi Riyal change in final demand of the transport sector results in a minor change in the agriculture, mining, utility, and services sectors. However, it causes a change of 3 halalhs on the oil sector, 2 halalhs on the manufacturing sector, 11 halalhs on the construction sector, 5 halalhs on the trade sector, and 7 halalhs on the finance sector. The numbers in column 8 of Table XXV show the total effects from a change of one Saudi Riyal in that sector's final demand while the rest of the sectoral final demand remains unchanged. If more than one sector's final demands change simultaneously, then the total effect can be obtained by multiplying the direct and indirect matrix, Leontief inverse, times the sectoral change in final demand. The indirect coefficients can be obtained by subtracting the direct coefficients, Table XXIV, from the direct and indirect coefficients, Table XXV.

5.2 The Human Resource Account

The development of this account is accomplished in the form of several matrices and vectors. These matrices are: (1) occupational labor coefficients, (2) sector by occupation, (3) educational labor coefficients, and (4) sector by education. The vectors required for the development of these accounts are: (1) total employment by sector, (2) total employment by occupation, (3) total employment by education, and (4) sectoral labor productivity.

The classification of the occupation and education into levels must be made prior to the attempt of developing this account. The

occupational and educational classifications of the Kingdom's manpower are shown in Tables XXVI and XXVII, respectively. This level of classification was selected because it coincided with the classification of the Ministry of Finance and National Economy and the Ministry of Labor and social affairs. For a detailed analysis of the occupational classification of the two ministries see Appendix A.

5.2.1 Occupational Labor Coefficients Matrix

The occupational labor coefficients matrix is shown in Table XXVIII. The table aids in analyzing the base year pattern of utilization of the Kingdom's labor force. The table is developed from two different publications [88, 64]. The IBRD occupational classification was aggregated into seven occupations to make it compatable with the classification adapted by the Ministry of Finance and National Economy and the Ministry of Labor and Social Affairs.

Table XXVII indicates that in the case of labor belonging to each of the industry specific occupations, a majority of workers among them are employed in the industry to which they actually belong. For example, about 58.5 percent of the total workers in the agriculture sector are working in agricultural related jobs. Similarly, 53.3 percent of the workers in the trade sector are working in sales. The numbers in the table reflect change in labor requirements in each occupation based on one unit change in the total sectoral employment. For example, if the total employment of the agricultural sector increases by one labor, this will result in an increase of professional and technical workers by 0.04623, managerial and administrative workers by 0.01233, clerical workers by 0.05162, . . ., etc. The rest of the coefficients can be analyzed in the same way.

TABLE XXVI

OCCUPATIONAL CLASSIFICATION IN SAUDI ARABIA

Occupations
1. Professional and technical workers
2. Administrative and managerial workers
3. Clerical and related workers
4. Sales workers
5. Service workers
6. Agricultural, animal husbandry, forestry, fishermen, and hunters
7. Production and related workers, transport equipment operators and laborers

TABLE XXVII

EDUCATIONAL CLASSIFICATION IN SAUDI ARABIA

Level	Education
1	Advanced studies
2	University degree
3	Some university
4	Technical high school
5	General high school
6	Intermediate school
7	Primary school
8	Read and write
9	Illiterate

TABLE XXVIII

OCCUPATIONAL LABOR COEFFICIENTS MATRIX (A_4)

Sectors	Professional & Technical 1	Managers & Administrators 2	Clerical Workers 3	Sales Workers 4	Services Workers 5	Agriculture Workers 6	Production Workers 7	TOTAL
Agriculture	0.04623	0.01233	0.05162	0.05470	0.02619	0.58513	0.22381	1.00
Oil	0.13698	0.02198	0.03001	0.14500	0.06001	0.00000	0.60602	1.00
Mining	0.06607	0.02257	0.08700	0.00601	0.01370	0.13036	0.67429	1.00
Manufacturing	0.03722	0.02645	0.03839	0.05034	0.02425	0.00088	0.82246	1.00
Utility	0.12721	0.00825	0.19002	0.00745	0.05898	0.00135	0.60674	1.00
Construction	0.07004	0.02035	0.05120	0.00752	0.04918	0.00178	0.79992	1.00
Trade	0.04094	0.02096	0.07416	0.53318	0.16643	0.00455	0.15978	1.00
Transport	0.08749	0.03373	0.13559	0.01610	0.08239	0.00284	0.64185	1.00
Finance	0.18347	0.08145	0.40277	0.13434	0.07851	0.00912	0.11032	1.00
Services	0.20030	0.01967	0.05340	0.05509	0.28575	0.00666	0.37913	1.00
Government	0.24202	0.02882	0.22000	0.10125	0.21000	0.00914	0.18877	1.00

5.2.2 Sector by Occupation Matrix

The sector by occupation matrix shown in Table XXIX represents the occupational mix of employment by sector in the base year. The numbers in this matrix are derived by multiplying the total sector employment in the base year by the corresponding row in the labor coefficient matrix. The entries in each row show the number of employees in each occupation working in that sector while the entries in each column show the number of employees working in that occupation in each sector. For example, the agricultural sector employs about 675,800 workers; of these about 31,240 are professional and technical workers, 8,230 are managers and administrative workers, 34,880 are clerical workers, 36,970 are sales workers, 17,700 are services workers, 395,430 are agricultural workers, and 151,250 are production workers. It is obvious to see that over one-half the workers in the agricultural sector are classified as agriculturalists.

To determine the total employment by sector vector, each row in the matrix is summed over the columns in the matrix. This sum is the vector of total employment by sector. The total employment by occupation is the last row in the above matrix. This vector shows the classification of total employment by occupation.

5.2.3 Educational Labor Coefficients Matrix

The educational labor coefficients matrix is shown in Table XXX. The elements of this matrix were derived from the same source as the occupational labor coefficients matrix [88, 64]. The types of education, if any, possessed by the workers, were divided into 9 levels, see Table XXVII.

TABLE XXIX

SECTOR BY OCCUPATION MATRIX
(IN THOUSANDS)

Sectors	Professional & Technical 1	Managers & Administrators 2	Clerical Workers 3	Sales Workers 4	Services Workers 5	Agriculture Workers 6	Production Workers 7	TOTAL
Agriculture	31.24	8.33	34.88	36.97	17.70	395.43	151.25	675.80
Oil	3.96	0.64	0.87	4.19	1.73	0.00	17.51	28.90
Mining	0.26	0.09	0.35	0.02	0.06	0.52	2.70	4.00
Manufacturing	2.94	2.09	3.03	3.97	1.91	0.07	64.89	78.90
Utility	2.35	0.15	3.52	0.14	1.10	0.02	11.22	18.50
Construction	13.75	4.00	10.06	1.48	9.66	0.35	157.10	196.40
Trade	7.29	3.73	13.21	94.96	29.65	0.81	28.46	178.11
Transport	11.36	4.38	17.61	2.09	10.70	0.38	83.38	129.90
Finance	2.92	1.30	6.40	2.14	1.25	0.15	1.75	15.91
Services	53.44	5.25	14.25	14.70	76.24	1.78	101.15	266.80
Government	62.93	7.49	57.20	26.33	54.60	2.38	49.08	260.00
TOTAL	192.44	37.45	161.38	186.99	204.60	401.89	668.46	1,853.21

TABLE XXX

EDUCATIONAL LABOR COEFFICIENTS MATRIX (A_5)

Sectors	Advanced Studies	University Degree	Some University	H. School Technical	H. School General	Inter-Mediate School	Primary School	Read & Write	Illiterate	TOTAL
Agriculture	0.00231	0.06549	0.00581	0.04738	0.02311	0.02851	0.02234	0.21148	0.59438	1.00
Oil	0.00631	0.14437	0.07252	0.13146	0.14290	0.15370	0.10526	0.21316	0.03032	1.00
Mining	0.00425	0.08012	0.05723	0.17195	0.05620	0.14101	0.20545	0.21316	0.07063	1.00
Manufacturing	0.00201	0.02880	0.01986	0.02640	0.03865	0.05355	0.06689	0.41702	0.34683	1.00
Utility	0.00383	0.08486	0.03265	0.06888	0.09936	0.08193	0.14557	0.23685	0.24607	1.00
Construction	0.00309	0.05401	0.02107	0.04064	0.08852	0.08453	0.09820	0.39210	0.21783	1.00
Trade	0.00222	0.03720	0.02368	0.01710	0.05896	0.07928	0.08869	0.42849	0.26438	1.00
Transport	0.00748	0.08218	0.03055	0.04577	0.15841	0.09173	0.08853	0.29717	0.19819	1.00
Finance	0.01629	0.19708	0.05171	0.03268	0.18254	0.10331	0.09238	0.22910	0.09491	1.00
Services	0.01585	0.07040	0.03829	0.04127	0.05710	0.11324	0.12278	0.28729	0.25366	1.00
Government	0.01950	0.04450	0.06850	0.12850	0.15300	0.27200	0.15130	0.09060	0.07210	1.00

Table XXX indicates that the majority of the Kingdom's labor force were below the primary school in their level of education. For example, about 59.4 percent of the laborers in agriculture are illiterate while only 0.23 percent hold an advanced studies degree. The high level of illiteracy among the agricultural workers can be attributed to several factors including: (1) the resistance of the people in the rural areas toward education in general and girls education in particular (see Chapter II), (2) women in the rural area are illiterate while they contribute to the output of the agricultural sector by working in the family's farm, and (3) the agricultural sector is a labor intensive sector depending on human power instead of mechanical power. The educational labor coefficient reflects the change in labor requirements in each educational level based on a one unit change in total sectoral employment. For example, if the total employment in agriculture increases by 1,000 new workers, 594 will be illiterate, 211 will know how to read and write, 22 will have primary school education, . . ., etc.

5.2.4 Sector by Education Matrix

The sector by education matrix shown in Table XXXI represents the educational mix of employment by sector in the base year. The entries in each row show the number of employees with their level of education working in that sector while the entries in each column show the number of workers possessing a certain level of education working in each row sector. For example, the oil sector employed about 28,900 workers in 1976; of these, about 180 hold advanced degrees, beyond the bachelor, about 4,170 have a university degree, about 2,100 have some

TABLE XXXI

SECTOR BY EDUCATION
(IN THOUSANDS)

Sectors	Advanced Studies	University Degree	Some University	H. School Technical	H. School General	Inter-Mediate School	Primary School	Read & Write	Illiterate	TOTAL
Agriculture	1.56	44.26	3.39	32.02	15.62	19.27	15.10	142.92	401.68	675.80
Oil	0.18	4.17	2.10	3.80	4.13	4.44	3.04	6.16	0.88	28.90
Mining	0.02	0.32	0.23	0.69	0.22	0.56	0.82	0.85	0.28	4.00
Manufacturing	0.16	2.27	1.57	2.08	3.05	4.23	5.28	32.90	27.36	78.90
Utility	0.07	1.57	0.60	1.27	1.84	1.52	2.69	4.38	4.55	78.50
Construction	0.61	10.61	4.14	7.98	17.39	16.60	19.29	77.01	42.78	196.40
Trade	0.40	6.63	4.22	3.05	10.50	14.12	15.80	76.32	47.10	178.11
Transport	0.97	10.68	3.97	5.95	20.58	11.92	11.50	38.60	25.75	129.90
Finance	0.26	3.14	0.82	0.52	2.90	1.64	1.47	3.65	1.51	15.91
Services	4.23	18.78	10.22	11.91	15.23	30.21	32.76	76.65	67.73	266.80
Government	5.07	11.57	17.81	33.41	39.78	70.72	39.34	23.56	18.75	260.00
TOTAL	13.53	114.00	49.07	101.78	131.24	175.23	147.09	483.00	638.37	1,853.21

university studies, . . ., etc. It is anticipated that the number of illiterate workers in this sector will be small, only 880 workers, when compared to other sectors. The reason is the capital intensive nature of this sector. The number in this matrix is derived by multiplying the total employment by sector times the educational labor coefficient matrix. The total employment by education vector shown as the last row in the sector by education matrix is determined by summing each column over rows in the matrix.

5.2.5 Sectoral Labor Productivity

Labor productivity or the output-employment coefficients are calculated by dividing sector output by total number employment. Productivity is defined as the value of output produced by each employee in each sector. Table XXXII represents the sectoral labor productivity of the Kingdom in 1976.

The oil sector achieved the highest rate of productivity, SR 3,503,579.53. This was anticipated since the oil sector is capital intensive. Agricultural productivity was at the other end of the scale with only about SR 9,758.73. Low productivity in agriculture can be attributed to the occupational mix in this sector and the fact that this sector is highly labor intensive. The service sector also shows low productivity, SR 16,470.49, when compared to the other sectors.

TABLE XXXII

SECTORAL LABOR PRODUCTIVITY, 1976
(IN SAUDI RIYAL)

Sector	Productivity
Agriculture	9,758.73
Oil	3,503,579.53
Mining	722,781.98
Manufacturing	117,349.32
Utility	52,402.33
Construction	190,249.65
Trade	129,574.07
Transport	131,998.35
Finance	965,055.02
Services	16,470.49

CHAPTER VI

THE FINAL DEMAND MODEL

Final demand consists of four exogenous sectors: private consumption, government consumption, gross fixed capital formation, and export. In this chapter, several projections will be developed for each sector based on past data. The validity of these functions will be checked using statistical as well as economic criteria. Based on these criteria, a single function will be selected to represent each final demand sector. The selected functions are then used to project the aggregate final demand of each exogenous sector. But before the development of the model, a brief survey of forecasting techniques is considered.

6.1 Forecasting Techniques

There are many techniques reported in the literature to forecast future events [95, 81]. Those techniques are broadly classified into qualitative and quantitative forecasting techniques [23]. Virtually all forecasting techniques fall into one of those two groups. However, there are many variations of each basic technique; thus, for a specific application, the analyst may combine or modify techniques to serve his or her needs.

6.1.1 The Qualitative Technique

This technique is used primarily when data are scarce, either

because there is no relevant history or good information is virtually nonexistent. It generally uses the opinion of experts to subjectively predict future events through accumulation of knowledge and intuition. The technique falls into two general categories of exploratory and normative character [81]. The exploratory technique uses events of the past on the present to move toward the future in a heuristic manner. On the other hand, the normative methods do the opposite by determining future goals and objectives, then moving backward to study the feasibility of its achievement. The qualitative technique is used in the current model and determins the growth rate of the independent variables from 1981 to 1990.

6.1.2 Quantitative Technique

This technique requires past historical data. Historical data are analyzed in an attempt to forecast future values of a variable of interest (dependent variable). The technique can be divided into two groups: Time Series and Causal Techniques.

Time series uses history of the variable to be forecast in order to infer something about its future behavior for prediction purposes. The time series technique may involve the use of a simple deterministic model such as a linear extrapolation or the use of a very complex box-Jenkins model. This type of technique is particularly useful when little is known about the under-lying process that one is trying to forecast. The limited structure in time series models makes them most reliable only in the short run.

The causal technique involves the identification of other variables (independent variables) that are related to the variable to be

predicted. It usually exploits the relationship between the variable of interest (private consumption, government consumption, gross fixed capital formation, export, import) and one or more other variables (GDP, world oil consumption, . . ., etc.). If the independent variables are correlated with the dependent variable of interest, then a statistical function describing this relationship can be developed. This is the most sophisticated kind of forecasting technique. It expresses mathematically the relevant causal relationship. The model which will be developed to project the aggregate final demand is of this type.

Both time series and causal techniques have advantages and disadvantages. On the advantageous side, the former can often be used more easily whereas the latter can be used with greater success for planning and decision making. On the disadvantageous side, the time series technique is useful only when conditions are expected to remain the same and only when the forecasting horizon is short. The causal technique has several disadvantages. First, it is somewhat more complicated to develop than the time series. Second, it requires data not only on the dependent variables but also on the independent variables. Third, the accuracy in predicting the value of the dependent variable depends not only on the validity of the function alone but also on the ability to correctly predict the future value of the independent variables. To overcome the last two disadvantages of this technique, the scenarios method will be incorporated into the causal technique. The scenarios method assumes that the future is multiple and several futures are possible [55]. The description of a potential future and of the progression toward it comprises scenarios. In this research, four different scenarios will be examined.

Qualitative and quantitative forecasting techniques by no means replace the decision maker or the planner. Instead, it provides them with an appropriate tool to assist them in making difficult decisions with regard to the uncertain future. A combination of quantitative and qualitative techniques will be used in order to arrive at the most appropriate model by which one can project the future aggragate final demand of each exogenous sector.

To arrive at the most appropriate model, several regression functions will be developed for each exogenous sector. Then, the statistical as well as the economical validity of these functions will be examined. The most accurate function is then selected to project future values. There are two types of regressive functions, linear and nonlinear. The linear function is of the following form:

$$Y_t = \beta_0 + \beta_i X_{i,t} + \beta_{i+1} X_{i+1,t} + \varepsilon_t \qquad (6.1)$$

where:

i is the number of independent variables,

Y is the dependent variable at year t,

X is the independent variable at year t,

ε is the random error term, and

β_0, β_i are the regression parameters to be estimated for each dependent variable by utilizing the least squares criteria.

The stochastic nature of the regression function implies that the value of the dependent variable cannot be forecasted exactly. This is due to the presence of the error term which imparts randomness on both the dependent and independent variables.

The nonlinear function can be classified as an intrinsically linear

function or an intrinsically nonlinear function [66]. The former is a function that is nonlinear with respect to the variable, but linear with respect to the parameters to be estimated. This type of nonlinear function can be easily linearized by a simple transformation of the variables. This indicates that what is applied to the linear model can be applied to the intrinsically linear function without any modifications. The intrinsically nonlinear function is a function that is nonlinear with respect to the variables as well as the parameters. In this research, the linear function and the intrinsically linear function will be considered because those types of functions have been used in the past for developing countries [1, 2, 136]. Some forms of the intrinsically linear functions and their transformation into an ordinary linear function are shown below:

Semi-log Function --

$$Y_t = \beta_0 + \beta_i \log X_{i,t} + \beta_{i+1} \log X_{i+1,t} \ldots + \varepsilon_t \qquad (6.2)$$

if $\log X_{i,t} = Z_{i,t}$ and $\log X_{i+1,t} = Z_{i+1,t}$.

Then the linear function will be

$$Y_t = \beta_0 + \beta_{i,t} Z_{i,t} + \beta_{i+1,t} Z_{i+1,t} + \ldots + \varepsilon_t. \qquad (6.2A)$$

The Exponential Function --

$$Y_t = \ell^{\beta_0 + \beta_i X_{i,t} + \beta_{i+1,t} X_{i+1,t} + \ldots + \varepsilon_t} \qquad (6.3)$$

Equation (6.3) can be rewritten as

$$\log Y_t = \beta_0 + \beta_i X_{i,t} + \beta_{i+1} X_{i+1,t} + \ldots + \varepsilon_t \qquad (6.3A)$$

if $\log Yt = Y_t^*$.

Then the linear function will be

$$Y_t^* = \beta_o + \beta_i X_{i,t} + \beta_{i+1} X_{i+1,t} + \ldots + \varepsilon_t. \qquad (6.3B)$$

The Double-log Function --

$$\log Y_t = \beta_o + \beta_i \log X_{i,t} + \beta_{i+1} \log X_{i+1,t} + \ldots + \varepsilon_t \qquad (6.4)$$

if $\log Y_t = Y_t^*$, $\log X_{i,t} = Z_{i,t}$ and $\log X_{i+1,t} = Z_{i+1,t}$.
Then the linear function will be

$$Y_t^* = \beta_o + \beta_i Z_{i,t} + \beta_{i+1} Z_{i+1,t} + \ldots + \varepsilon_t. \qquad (6.4A)$$

6.2 Statistical Criteria

The statistical accuracy of the model must be established before it could be used to forecast the future value of the final demand. Although there are many statistical criteria by which one can examine the accuracy of a model, only three criteria will be considered here. Those are the standard deviation of the residual, S, the goodness of fit, R^2, and the F-test.

6.2.1 The Standard Deviation S

This criteria measures the difference between the actual and predicted value of the dependent variable. In reality, perfect prediction is practically nonexistent. What is needed, then is a criteria by which one can determine or base judgment on how precise the prediction is of the dependent variable by the proposed model. The standard deviation S is calculated as:

$$S = \sqrt{\frac{\sum_{t=1}^{n} (Y_t - Y_t)^2}{n - (i + 1)}} \qquad (6.5)$$

Y_t is the actual value of the dependent variable at year t,

where t = 1, . . ., n,

n is the number of observation,

Y_t is the predicted value of the dependent variable at year t,

i is the number of independent variables in the model.

As can be seen from the denominator, as the number of observations increase, the value of S decreases. In other words, as the degrees of freedom [n - (i+1)] increase, the value of S decreases. This indicates that the degrees of freedom can be used as a supporting criteria in measuring the overall accuracy of the model. The nominator indicates that the value of S is dependent on the unit in which the historical data are measured in. One can conclude that S is not a unit free measure and a model accuracy must not be judged solely on the magnitude of S. Because of this, a unit free criteria is needed which is independent of the unit size of the observation.

6.2.2 The Goodness of Fit R^2

The standard deviation helps in providing a useful measure of the extent to which the estimated regression line fits the data. Roughly speaking, a good regression model is one which helps to explain a large proportion of the variation in the dependent variable. The goodness of fit R^2 is an index which measures the effectiveness of the independent variable(s) in explaining the variation in the dependent variable. The

value of this index varies between zero and one. A value of zero indicates no relationship between the dependent variable and the independent variables, while a value of one reflects a perfect relationship. That the larger the value of R^2, the greater is the utility of the overall model in describing the behavior of the dependent variable. Mathematically, the value of R^2 is calculated as:

$$R^2 = \frac{\sum_{t=1}^{n} (\hat{Y}_t - \bar{Y})^2}{\sum_{t=1}^{n} (Y_t - \bar{Y})^2} \tag{6.6}$$

where $\bar{Y}$ is the mean of the actual values of Y.

This criteria, R^2, is a unit-free measure as compared with the residual of a regression. However, R^2 is dependent on the number of independent variables in the model. As the number of independent variables in the model increases, the value of R^2 will increase. This shortfall of R^2 has to be taken into consideration when the different models are analyzed. Therefore, R^2 alone is not a sufficient measure in testing the overall performance of the model.

6.2.3 The F-Test

The F-test measures the overall significance of the model by providing a way for testing the hypothesis that the regression model will be better than the mean as a method of forecasting [81]. In other words, it tests the hypothesis that none of the independent variables helps to explain the variation in the dependent variable about its mean. It is calculated as:

$$F_{i,n-i} = \frac{\frac{\sum_{t=1}^{n}(Y_t - \bar{Y})^2}{i}}{\frac{\sum_{t=1}^{n}(Y_t - Y_t)^2}{(n - (i + 1))}} = \frac{\text{Explained Variance}}{\text{Unexplained Variance}} \qquad (6.7)$$

One can see that the value of F depends on the number of independent variables in the model as well as on the number of observations. As the number of observations increase, the denominator decreases and the value of F increases. The value of F calculated by Equation (6.7) is measured against a tabulated value of F [23]. If the calculated F is greater than the tabulated F, then all the independent variables in the model are significant.

One can see that each criteria has a shortfall. Based on this fact, the validity of each function will not be judged on its satisfaction of one of these criteria. A compromise in the degree of satisfaction of all these criteria by a function has to be considered. The function which satisfied those criteria relatively greater than the other functions will be selected as the most appropriate function statistically.

6.3 The Development of the Final Demand Model

Each aggragate final demand will be projected in terms of changes in other variables. The choice of variables depends on the theoretical desirability of those variables and the availability of historical data. However, there are eight major phases in the development and application of the appropriate final demand model. Those phases are: (1) designing the form of the different functions making up the model, leaving out

part of the actual data, 1978 to 1980; (2) evaluating the estimated parameters of those functions; (3) checking the accuracy of those functions statistically; (4) utilizing the most promising functions to project the actual data which has been left out; (5) testing the accuracy of those functions in projecting the actual data using the mean absolute deviation, MAD, and the square root of the mean squared error, RMSE, criteria; (6) choosing the appropriate function accordingly; (7) re-estimating the parameters of the appropriate function by incorporating the left-out data; and (8) utilizing the function to project the future value of the dependent variable.

The dependent and independent variables are defined in Table XXXIII. The list of the independent variables stated above are the most disaggregate variables available which seem to relate to the dependent variables. Future projection of the growth rate of the independent variables are available in the literature [40, 92, 102, 143]. One or a combination of the listed independent variables will be used to project each dependent variable. The historical data of the dependent and independent variables are shown in Tables XXXIV and XXXV, respectively.

The development of the final demand model will be divided into three stages: (1) development of the consumption function, (2) development of the gross fixed capital formation function, and (3) development of export function.

6.3.1 Consumption Function

Consumption represents both the concluding stage of each reproduction cycle and the initial basis for the subsequent cycle. Consumption activities are divided into two types, namely, productive or intermediate

TABLE XXXIII

INITIALIZATION OF THE VARIABLES IN
THE FINAL DEMAND MODEL

The Dependent Variables:	Description
PC_t	Private consumption in year T
GC_t	Government consumption in year T
GCF_t	Gross capital formation in year T
Exp_t	Export in year T
IM_t	Import in year T
The Independent Variables:	
GDP_t	Total gross domestic product in year T
GDP_{t-1}	Total gross domestic product in year T-1
$NoGDP_t$	Non-oil GDP in year T
$NoGDP_{t-1}$	Non-oil GDP in year T-1
$OGDP_t$	Oil GDP in year T
$OGDP_{t-1}$	Oil GDP in year T-1
GR_t	Government revenue in year T
GR_{t-1}	Government revenue in year T-1
GC_{t-1}	Government consumption in year T-1
PC_{t-1}	Private consumption in year T-1
TC_t	Total consumption in year T
IM_t	Import in year T
WOC_t	World oil consumption in year T

TABLE XXXIV

THE HISTORICAL DATA OF THE DEPENDENT VARIABLES
(1960 - 1980) in MSR

Year	PC	GC	GCF	Exp	IM
1960	2,127	743	496	3,762	918
1961	2,186	887	808	4,298	1,053
1962	2,195	1,050	1,030	4,712	1,155
1963	2,742	1,244	1,176	4,975	1,364
1964	2,835	1,430	1,209	5,528	1,564
1965	2,910	1,654	1,712	6,288	1,948
1966	3,026	1,915	2,330	7,266	2,255
1967	3,177	2,437	2,327	7,734	3,538
1968	3,368	2,652	2,544	8,486	4,392
1969	5,360	3,026	2,632	9,086	4,851
1970	5,859	3,421	2,597	10,302	4,990
1971	6,412	3,798	2,932	15,189	5,205
1972	6,914	4,285	3,403	19,862	6,303
1973	7,896	5,335	5,694	30,012	8,272
1974	9,827	9,864	8,400	85,682	15,293
1975	18,039	15,911	17,699	114,461	27,257
1976	23,903	28,883	33,540	120,284	42,863
1977	34,372	41,033	51,191	140,321	62,699
1978	54,607	47,034	66,891	140,762	91,505
1979	68,608	71,904	76,654	147,236	107,479
1980	83,948	88,206	97,068	258,488	132,351

Sources: [2, 1960 to 1969; 111, 1970 to 1980].

TABLE XXXV

THE HISTORICAL DATA OF THE INDEPENDENT VARIABLES
(1960 - 1980) in MSR

Year	GDP	NoGDP	OGDP	GR	TC[1]	WOC[2]
1960	6,210	2,894	3,316	1,579	2,870	60,528
1961	7,122	3,233	3,889	1,720	3,073	65,794
1962	7,832	3,601	4,231	2,085	3,245	71,716
1963	8,673	4,041	4,632	2,365	3,986	79,081
1964	9,319	3,722	5,597	2,656	4,265	85,325
1965	10,404	4,420	5,984	3,082	4,564	91,890
1966	11,939	5,101	6,838	3,982	4,941	98,419
1967	13,228	5,614	7,614	5,025	5,614	105,909
1968	14,639	6,787	7,852	4,937	6,020	114,726
1969	15,975	7,022	8,953	5,535	8,386	126,288
1970	17,399	7,067	10,332	5,741	9,280	135,484
1971	22,921	8,866	14,055	7,954	10,210	181,428
1972	28,258	10,532	17,726	11,116	11,199	192,542
1973	40,551	12,456	28,095	15,326	13,231	380,574
1974	99,315	16,477	82,838	40,597	19,691	818,882
1975	139,600	29,138	110,462	100,103	33,950	814,272
1976	164,526	49,004	115,522	103,384	52,786	925,109
1977	205,056	70,369	134,687	135,957	75,405	1,070,098
1978	225,400	93,336	132,064	132,241	101,641	1,066,438
1979	249,539	110,999	138,540	131,505	140,512	1,531,188
1980	385,807	135,761	250,046	211,196	172,154	2,105,529

Sources: [2, 1960 to 1969; 111, 1970 to 1980].

[1]TC is obtained by adding PC and GC columns shown in Table XXXIV.

[2]WOC, as shown in the last column, has been obtained by changing the world oil consumption given in barrels by day into a monetary value to match with the rest of the values of the other variables in the model.

and non-productive or final demand. The latter includes private consumption as well as those consumption activities of the Government that are associated with the performance of its political functions and with its role in the operation of social infrastructure. The former is used by the different sectors of the economy in the process of producing output. This section will be concerned with the development of the non-production consumption function.

For the purpose of this research, consumption has been split into two different functions: (1) private consumption and (2) Government consumption.

There are several reasons for this division. First, the almost total dependence on oil and the fact that oil is owned and controlled by the Government and does not yet appreciably affect the lifestyle of the majority of individuals living in Saudi Arabia [14]. To prove this reasoning, PC and GC will be treated as a function of GDP, then GDP will be split into NoGDP and OGDP. PC will be treated as a function of NoGDP and GC as a function of OGDP. Second is the strong belief among economists that the split of consumption into its components, PC and GC, will result in a better estimate. Third, the two types of consumption have grown at different rates duriung the past two decades. In 1960 PC was three times as much as GC, while in 1980, GC exceeded that of PC (see Table XXXIV). Lastly, the availability of historical data in both types of consumption encouraged the division.

6.3.1.1 Private Consumption Function. Private consumption is influenced by several factors--economic, social, natural, climatic, and political. For example, consumption of urban residents differs considerably from that of rural residents. Unfortunately, this type

of disaggregation is not available for Saudi Arabia, and the list of variables given in Table XXXIII are the most disaggregate data available. The economic factor is the only factor affecting private consumption considered in this research.

In developing the appropriate private consumption function, the simple linear regression and the simple intrinsically linear regression functions are investigated first. Then there is a gradual move to more advanced functions. The choice of the function used to project the future total private consumption depends on statistical as well as economic criteria.

Several different types of functions were examined using PC as a dependent variable and one or a combination of GDP, NoGDP, and GR as independent variables. The most promising functions are shown in Table XXXVI. Those functions were developed using historical data from 1960 to 1977, leaving out the last three years, 1978 to 1980. All functions exhibit a strong goodness of fit, R^2, of 0.98 or higher (Table XXXVI). This means that the independent variables in the function explain 98 percent or more of the variation in the dependent variable. The main reason behind the high value of R^2 lies in the choice of the independent variables. The values of the F's are all significant when compared to their corresponding value of the tabulated F's.[1] The large values of the calculated F's shown in the table reflect the overall significance of the functions as a method to forecast the future value of the PC. The residual value of S given by the linear functions are significantly higher than that given by the intrinsically nonlinear functions. This

---

[1]To determine the corresponding value of the tabulated F_S of each function, consult any statistical book.

TABLE XXXVI

ESTIMATE OF THE PAREMETERS AND STATISTICAL CRITERIA OF THE PC FUNCTIONS

No.	Function	a	b	c	S	R^2	F	MAD	RMSE
6.8	$PC_t = a + b\ GDP_t + cPC_{t-1}$	-302.405	.051	.961	1,092.585	.987	530.59	5,149	6,413
6.9	$PC_t = a + b\ NoGDP_t + cPC_{t-1}$	783.814	.383	.304	1,059.745	.988	564.42	8,883	8,951
6.10	$PC_t = a + b\ GR_t + cPC_{t-1}$	283.784	.085	.898	715.007	.994	1,248.27	8,143	8,791
6.11	$\log PC_t = a + b \log GDP_t + c \log PC_{t-1}$	-.290	.275	.726	.125	.981	355.30	5,790	7,213
6.12	$\log PC_t = a + b \log NoGDP_t + c \log PC_{t-1}$	-.279	.523	.491	.116	.983	416.28	2,577	2,808

is because the residual is not a unit-free estimate as mentioned earlier. The intrinsically nonlinear functions, double logged functions, by logging the data, significantly reduce the magnitude of their values.

The estimate of the three statistical criteria of all the functions shown in Table XXXVI are statistically significant. The parameters of those functions make sense economically. The positive sign of the parameters associated with the independent variables indicate that, as the value of those variables increase, the value of PC will increase also. Based on this, one can conclude that all the functions are statistically significant and make sense economically. However, one, and only one, function has to be chosen to project the future value of PC.

All the functions shown in Table XXXVI are used to project the values of PC for the years 1978 to 1980, using the actual value of the independent variables. Then the projected values derived from those functions will be compared against the actual values of PC. Based on those comparisons, the most appropriate function will be determined. The MAD and RMSE are used to test the accuracy of those functions in projecting the future values of PC. The function which gives the lowest value of MAD and RMSE is chosen as the most appropriate function to project the future value of PC.

According to Table XXXVI, the lowest values of MAD and RMSE are given by Function (6.12). The independent variables NoGOP and PC_{t-1}, in this function explain about 98.3 percent of the total variation in the PC. The magnitude of the parameter associated with the independent variable PC_{t-1}, 0.491, indicates that PC_{t-1} is a powerful explanatory variable and it should be included in the specification of the private

consumption function. The private marginal propensity to consume, MPC_p, of 0.523 given by this function means that more than 50 percent of NoGDP will be consumed by the private sector. The main reason which could be attributed to the low value of MPC_p is the existence of a high percentage of non-Saudi nationals in the country whose main purpose is to work and save as much money as possible. The poor performance by the functions in which GDP and GR played the role of independent variable support the hypothesis that oil revenue does not yet appreciably affect the life style of the majority of individuals living in Saudi Arabia [14]. One cannot ask for a better function to project the future value of PC than Function (6.12).

6.3.1.2 Government Consumption Function. The Government of Saudi Arabia derives its wealth from oil revenue which is owned and controlled by the Government. This is one reason for the division of the consumption function. Based on this, one expects a high value of the Government marginal propensity to consume MPC_G.

Several types of functions were examined using GC as a dependent variable and one or a combination of GDP, OGDP, and GR as independent variables. The statistical validity of those functions were examined. The most promising functions are shown in Table XXXVII. Only data from 1960 to 1977 were used in determining the parameters of those functions. The statistical criteria of those functions are significant. The independent variables explain about 99 percent of the variation in the dependent variable GC (Table XXXVII). The calculated F's of those functions are significant when compared to the value of their corresponding tabulated Fs. The value of the residuals are reasonable when taking into consideration the magnitude in which the data were measured. It is

difficult to select the most appropriate function to project GC based on the above-mentioned criteria.

All the parameters in the selected functions have the correct sign. The positive sign of those parameters indicates a positive linear correlation between GC and the independent variables. Two important conclusions can be drawn from the functions. First, in the linear functions, the effect of the first independent variable on the dependent variable is very small, but statistically significant. Second, the Government past consumption, GC_{t-1}, is a powerful explanatory variable and should be included in the specification of the government consumption function. Before passing a final judgment on the performance of those functions, one must examine their actual predictive ability. The last two columns in Table XXXVII show the value of MAD and RMSE obtained by the utilization of the functions in the table to project the actual value of GC for the years 1978 to 1980. The lowest value of MAD is given by Function (6.18) while the lowest value of RMSE is given by Function (6.15). Because of this conflict, one must study these two functions closely to determine which is more suitable to project the future value of GC. From a statistical point of view, Function (6.18) is better than Function (6.15) (see Table XXXVII). Based on this finding, one is inclined to choose Function (6.18) over Function (6.15).

6.3.2 Gross Capital Formation

In the 60's, gross capital formation, GCF, of Saudi Arabia was dominated by the construction sector and continued throughout the 70's due to an increased level of liquidity in the economy. The share of

TABLE XXXVII

ESTIMATE OF THE PAREMETERS AND STATISTICAL CRITERIA OF THE GC FUNCTIONS

No.	Function	a	b	C	S	R	F	MAD	RMSE
6.13	$GC_t = a + b\ NoGDP_t + CGC_{t-1}$	-719.191	.055	1.087	1,107.174	.991	808.42	9,398	9,500
6.14	$GC_t = a + b\ OGDP + CGC_{t-1}$	-654.984	.056	1.219	1,190.509	.990	698.25	9,995	10,231
6.15	$GC_t = a + b\ GR_t + CGC_{t-1}$	-226.328	0.076	1.113	1,252.024	.989	630.65	8,632	8,677
6.16	$\log GC_t = a + b \log GDP_t + C \log GC_{t-1}$	-1.199	.376	.704	.0656	.997	2,364.12	9,506	9,628
6.17	$\log GC_t = a + b \log OGDP_t + C \log GC_{t-1}$	-.711	.285	.775	.072	.997	1,988.70	9,487	9,798
6.18	$\log GC_t = a + b \log GR_t + C \log GC_{t-1}$	-.040	.319	.671	.068	.997	2,168.66	7,041	9,373

the construction sector in total GCF rose continuously during the FDP and the SDP until it reached about 83 percent of GCF in 1979 [111]. The main reason for this domination by the construction sector was not the absence of alternative investment opportunities but the unwillingness of the private sector to invest in building factories to ease the country's total dependence on imports. Building highways and high rise apartment complexes did not lessen the country's total dependence on imports nor did it reduce dependence on oil as a source of income. In the first year of the TDP, the share of the construction sector in GCF declined for the first time. This gives hope that investment in Saudi Arabia is moving in the right direction.

The Government is the major contributor to GCF. It contributes about 65 percent of the total GCF, while that of the non-oil private sector contributes only about 24 percent [111]. This indicates that the Government sector plays an important role in fueling the economy. The Government encourages the development and participation of the private sectors of the country through generous loans and subsidies.

The most appropriate method of estimating the GCF demands for the output of the various sectors in an economy is to treat them as endogenous variables in the input-output model and derive them simultaneously with the solution of sector outputs. However, this would require a capital-coefficient matrix which does not exist for the Saudi Arabian economy. Because of this limitation, GCF will be treated as an exogenous column vector. This vector shows the total demand for all sectors of capital goods but does not show the details of the purchasing sectors. The detailed distribution of GCF over the different sectors of the economy is available only for the base year 1976, as is the case

with the other exogenous sectors. Because of this, the aggragate GCF will be used to determine the appropriate function. Then, the projected total GCF will be distributed among the various sectors of the economy based on 1976 proportions.

Based on the above findings, the same procedures used to determine the appropriate PC and GC functions were used. From the several functions examined, only three functions displayed promising statistical estimates. Those functions are:

$$GCF_t = -243.215 + 1.077\ IM_t - 0.079\ GDP_t \qquad (6.19)$$

$$\log GCF_t = 0.480 + 0.844 \log GR_t \qquad (6.20)$$

$$GCF_t = -785.710 + 0.796\ IM_t \qquad (6.21)$$

Function (6.19) is rejected because the estimate of the parameter associates with the explanatory variable GDP has a negative sign. The negative sign reflects the existence of a negative correlation between the independent variable GDP and the dependent variable GCF. Economically, this is not possible because GCF is part of GDP and an increase in GDP has to be accompanied by an increase in GCF.

The estimates of S, R^2, and F of Function (6.20) are 0.251, 0.962, and 402.49, respectively. The estimate of those statistical criteria are significant by any conventional test. Economically, the function makes sense. The parameter of the independent variable, GR, shows the right sign. The high marginal propensity to invest (MPI_G) with respect to GR, 0.844, reflects the important role the Government is playing in fueling the economy of the country. The only shortfall of this function is the low value of its R^2. But this is not a good reason to reject the

validity of the function in projecting the future value of GCF with a reasonable accuracy.

Function (6.21) gives a very good fit statistically, $R^2 = 0.99$. The estimate of the other two statistical criteria, F and S, given by this function are 1584 and 1392, respectively. Their values indicate that the function is statistically significant and better than the mean value in projecting the future value of GCF. The explanatory variable IM is able to explain about 99 percent of the variation in the dependent variable GCF. The high value of R^2 indicates the existence of a strong relationship between GCF and IM. The positive sign of the parameter of the independent variable IM indicates the existence of a positive correlation between GCF and IM. The marginal propensity to invest with respect to import, MPI_M, is 0.796. Based on the above analysis, one cannot reject Function (6.21).

To determine whether Function (6.20) or Function (6.21) is the most appropriate function to represent the future direction of GCF, the accuracy of these two functions in projecting the actual value of GCF for the years 1978 to 1980 is utilized. The values of MAD and RMSE obtained by the implementation of Function (6.20) are 40,806 and 41,216, respectively, compared to 6,924 and 4,329 obtained by Function (6.21). Now, one can say with confidence that Function (6.21) is more appropriate accurate than Function (6.20) in projecting the future value of GCF. This conclusion is based on the statistical criteria of those two functions as well as on their ability to forecast the actual data of GCF.

6.3.3 Export and Import Functions

The economy of Saudi Arabia is different in nature than most

developing or developed countries. The country depends on imports to meet demands for goods and services and on oil revenue to pay for those demands. Oil is the major exporting commodity. It constitutes more than 90 percent of total exports of the country over the past two decades, 60's and 70's [111]. This indicates that no noticeable structural changes in the composition of exports were experienced during that period. During the TDP and possibly the FDP, other exports constituted a negligible amount, particularly with the inclusion of natural gas liquidation under oil exports and the country's concentration on petrochemical industries.

During the 1960's, Saudi Arabian exports rose from 3,762 MSR to 9,089 MSR or about 9.3 percent per year. World oil consumption, WOC, rose from 22,254 Mb/d to 42,715 Mb/d or about 7 percent per year. The increase in world economic growth and stability of oil prices during the 60's was the major factor behind the significant increase in WOC.

In 1970, Saudi Arabia became the world's largest exporter of petroleum. Today, it has the largest known reserves in the world and the largest off-shore and on-shore field but it is second to the Soviet Union in production [71]. This is reflected by the 47 percent increase in exports in 1971 compared to the 13 percent increase in the previous year. During the FDP and SDP periods, exports increased by 62 percent and 18 percent per year, respectively. The low increase during the SDP could be attributed to the economic recession that the world was experiencing at that time. The effect of world economic slowdown on oil consumption and, in turn, on Saudi Arabian exports could be detected by the slow increase in WOC. During the period from 1973 to 1980, WOC increased by less than 2 percent per year compared to more than 8

percent per year during the period from 1960 to 1973.

It is difficult to derive a suitable function by which one can project the country's future exports. This difficulty stems from the fact that both supply and demand for exports is determined in relation to external as well as internal forces. Those forces are economic as well as political. The political forces are hard to speculate about and are beyond the scope of this research. Some of the economic forces are, on one side, the Government need of income for the development of the country, and, on the other side, the world economic situation. This makes the consideration of world economic growth rate as an explanatory variable worth investigating. But, because oil exports for Saudi Arabia account for more than 90 percent of total exports, WOC is obviously a better candidate to explain the variation in exports.

The ability of WOC to explain the variation in Saudi exports is tested by several different types of functions. The linear and double log functions are the only functions which give a high value of R^2, more than 98 percent, and a significant and reasonable value of F and S. The estimate of those functions are shown below.

$$Exp_t = -6,967.618 + 0.134\ WOC_t \qquad (6.22)$$

$$\text{Log } Exp_t = -5.563 + 1.253 \text{ log } WOC_t \qquad (6.23)$$

The S, R_2, and F values of the double log function are 0.099, 0.994, and 2,718 which are more significant than the values given by the linear function, 6,590, 0.981, and 831, respectively. The difference between the values of the two, R^2, 0.013, is very small and both Fs are significant when compared to the tabulated value of F. A comparison between the two values of S is not possible because of the different magnitude of the

data used to calculate the two Ss. Based on this comparison alone, one cannot choose one function over the other with confidence. The accuracy of those two functions in projecting the future value of Exp is the best and deciding criteria which one can use to project the values of Exp for the years 1978 to 1980. The values of Exp projected by those functions are compared to the actual values of Exp of the same period. From those comparisons, the values of MAD and RMSE for Function (6.22) are 24,163 and 31,093, respectively, compared to 45,052 and 53,768 given by the other function. Based on the values of MAD and RMSE, one can conclude that Function (6.22) projects the future value of Exp with a greater accuracy than Function (6.23).

The last function in the final demand model is the import function IM. From the several different functions tried, the most acceptable functions based on the statistical criteria are:

$$IM_t = -4,271.408 + 1.906\ PC_t \qquad (6.24)$$

$$IM_t = -1,324.082 + 0.513\ PC_t + 1.129\ GC_t \qquad (6.25)$$

The two functions shown above have almost a perfect goodness of fit. The independent variables, PC and GC, in Function (6.25), explain about 99.9 percent of the variation in the value of IM compared to 99.0 percent explained by PC in Function (6.24). The standard deviations associated with the two functions, (6.24) and (6.25), are 1,812 and 644, respectively, and their values of F's are statistically significant.

Based on the comparison of values of R^2, S, and F, one cannot choose one function over the other with great confidence. Function (6.25) shows a slight superiority over Function (6.24) with respect to

those statistical criteria. One can attribute this superiority to the bute this superiority to the increase in the number of the independent variables in the function.

Both functions make sense, economically. They show a positive relationship with private consumption and with private and Government consumption. The marginal propensity to import MPM with respect to private consumption is 1.906 compared to 0.513 and 1.129 of the PC and GC, respectively. Once again, one must select one, and only one, function to project the future path of IM.

The accuracy of those functions in projecting the actual value of IM during the period 1978 to 1980 was utilized. Function (6.25) gives a slightly better estimate of the actual values of IM than Function (6.24) based on the magnitude of MAD and RMSE of the two functions. Based on the above analyses and the fact that the economy of Saudi Arabia exhibits a clear-cut separation between the private and Government sectors, one is inclined to select Function (6.25) over Function (6.24).

6.3.4 Updating the Estimated Parameters of the Model

The functions chosen in the previous sections were estimated based on the data from 1960 to 1977. The first thing one must do prior to the utilization of those functions is to update their estimate by using the full data base--data from 1960 to 1980. The estimates of the updated parameters of those functions are shown below:

$$\log PC_t = -0.277 + 0.551 \log NoGDP_t + 0.461 \log PC_{t-1} \qquad (6.26)$$

$$\log GC_t = -0.128 + 0.292 \log GR_t + 0.713 \log GC_{t-1} \qquad (6.27)$$

$$IM = -1,906.280 + 1.269\ PC_t + 0.364GC_t \quad (6.28)$$

$$GCF_t = -311.196 + 0.738\ IM_t \quad (6.29)$$

$$Exp_t = -4,437.532 + 0.122\ WOC_t \quad (6.30)$$

6.4 Utilization of the Final Demand Model

The previous sections dealt with the development of the final demand model. This section utilized the model to project future values of each final demand sector. Projection starts with the year 1976 and proceed until 1990. However, before this model can be utilized, the future values of the following independent variables, NoGDP, GR, and WOC, must be determined.

Because of the special nature of the economy of Saudi Arabia of total dependence on oil for income and imports for goods and services, the future growth rate of those independent variables will be estimated by four different sources. Each source will represent a scenario. The first source is the ministry of planning, MOP, and the organization of the petroleum exporting countries, OPEC. MOP estimates that NoGDP and GR will grow by 6.2 and 1.34 percent annualy, respectively, during the TDP [92].[2] This rate of growth is expected to continue during the FODP period. OPEC, of which Saudi Arabia is a member, estimates the growth rate in world oil consumption, WOC, to be 2.4 percent annually during the coming decade [102]. Those estimates given above are the insider's view, Scenario A of the expected annual rate of growth of the independent variables.

---

[2]The annual growth rate in the oil sector is used instead of the annual growth rate in GR because the future estimation of the latter is not available either in Government or other publications.

The second source of estimation, Scenario B, is the outsider's expectation of the annual rate of growth of those variables. The World Bank estimates that the world oil consumption will increase by about 2.0 percent per year during the period from 1980 to 1990 [143]. This estimate is very close to the one given by OPEC in Scenario A. Cleron's book, Saudi Arabia 2000, projected the annual growth rate of NoGDP and GR to be 11.8 and 3.2 percent, respectively [40].[3]

The value of the independent variable, NoGOP, is climbing steadily during the period of 1960 to 1974, but, in 1975, it increases significantly (see Table XXXV). The same thing was experienced by the other two independent variables, GR and WOC, except that the sudden jump in the values of those two variables started in 1974. Based on this finding, the historical data of those variables were divided into two data sets. The first data set contains the data prior to the sudden jump in the value of those variables, while the second data set contains the data after the jump had occurred.

Each independent variable in the first data set is regressed on time. The equations resulting from this regression are shown below:

$$NoGDP_t = 466.038 + 790.354_t \qquad (6.32)$$

$$GR_t = -1,034.231 + 834.116_t \qquad (6.33)$$

$$WOC_t = 8,860.154 + 15,863.446_t \qquad (6.34)$$

The above equations were used to estimate the annual rate of growth of the independent variables. The annual growth rate of the variables

---

[3]Same as footnote 2.

NoGDP, GR, and WOC are 4.5, 5.2, and 4.6, respectively. Those estimations are labeled as Scenario C. The same procedure was repeated using the second data set. The equations and their estimated parameters derived by regressing those variables on time are shown below:

$$NoGDP_t = 113,974.143 - 21,201.914t \quad (6.35)$$

$$GR_t = 35,932.143 + 21,552.071t \quad (6.36)$$

$$WOC_t = 413,773.429 + 194,110.786t \quad (6.37)$$

Scenario D represents the estimated annual growth rate of the variables, NoGDP, GR, and WOC obtained from the above equations and are 9.2, 8.9, and 6.6 per year, respectively. The estimations of the future values of the three independent variables by the four different scenarios are shown in Table XXXVIII.

Projected Government consumption, private consumption, gross capital formation, exports, and imports obtained by the implementation of the final demand models for the four scenarios are shown in Tables LIII through LVI in Appendix B. All the scenarios projected a steady annual growth rate in the values of the independent variables in the model. This growth rate differs from one scenario to the other. The estimated growth rates of Scenario A seem to be more realistic than those for the other three scenarios. The estimates given by Scenario B are very similar to those given by Scenario A except with respect to the rate of growth of NoGDP. Scenario B estimated the rate of growth of NoGDP at about double that given by Scenario A. The other two scenarios, C and D, can be called the pessimistic and optimistic scenarios, respectively. The main objective in considering those scenarios is to analyze the

TABLE XXXVIII

THE ESTIMATED FUTURE VALUE OF THE INDEPENDENT VARIABLES FOR THE FOUR SCENARIOS (IN MSR)

	Scenario A			Scenario B			Scenario C			Scenario D		
	NoGDP	GR	WOC	NoGDP	GR	WOC	NoGDP	GR	WOC	NoGDP	GR	WOC
1981	144,178	214,026	2,156,062	151,781	217,954	2,147,640	141,870	222,178	2,202,383	148,251	229,992	2,244,494
1982	153,117	216,894	2,207,807	169,691	224,929	2,190,592	148,254	233,731	2,303,693	161,890	250,462	2,392,631
1983	162,611	219,800	2,260,795	189,714	232,127	2,234,404	154,926	245,885	2,409,663	176,784	272,753	2,550,544
1984	172,692	22,746	2,315,054	212,101	239,555	2,279,092	161,898	258,672	2,520,507	193,048	297,028	2,718,880
1985	183,399	225,731	2,370,615	237,129	247,220	2,324,674	169,183	272,122	2,636,451	210,809	323,463	2,898,326
1986	194,770	228,755	2,427,510	265,110	255,131	2,371,168	176,796	286,273	2,757,725	230,203	352,252	3,089,616
1987	206,846	231,821	2,485,770	296,393	263,296	2,418,591	184,752	301,159	2,884,583	251,386	383,602	3,293,530
1988	219,670	234,927	2,545,428	331,367	271,721	2,466,963	193,066	316,819	3,017,274	274,509	417,743	3,510,903
1989	233,290	238,075	2,606,519	370,468	280,416	2,516,302	201,754	333,294	3,156,068	299,764	454,926	3,742,623
1990	247,754	241,265	2,669,075	414,184	289,389	2,566,628	210,833	350,625	3,301,247	327,342	495,410	3,989,636

country's needs of manpower under extreme situations. Table LX (see Appendix B) shows a list of all the estimated annual growth of the independent variables in all four scenarios.

CHAPTER VII

THE MANPOWER REQUIREMENT MODEL

The purpose of this chapter is fourfold. The first purpose is the development of the manpower requirement model. In this part, the different components of the model are developed and linked together. Time series and causal techniques are used to derive an estimation of the future value of some of the components of the model. However, the main approach to sectoral manpower requirement used in this research is the open-static input-output analysis. The second purpose is to test the accuracy and validity of the model. In this part, the model will be utilized to project the manpower requirement by sector for the years 1977 to 1980. This period is the test period because actual data on manpower by sector are available. The third purpose is to implement the model to project the manpower requirement by sector, occupation, and education up to 1990 (inclusively). The last purpose is to analyze the results obtained from the implementation of the model.

7.1 The Development of the Manpower Requirement Model

In the previous chapter, each aggregate final demand component was projected through the utilization of the final demand model. Those projections were used as inputs into the manpower requirement model developed in this chapter. The development of the model consists of

four stages. In the first stage, each aggregate final demand component is distributed over the various sectors of the economy based on the base year proportionality. The data needed for the execution of this stage are shown in Appendix B. The second stage of the model involves estimation of the annual rate of change of each sector productivity. This annual change of productivity enter into the model in the form of labor-output coefficients for each sector. In the third stage, the projected sectoral final demands were used to determine the sectoral output through the utilization of the input-output analysis. The data needed for the execution of this stage were tabulated in a matrix form in the first half of Chapter V. In the last stage, the projected sectoral outputs and the annual rate of change in productivity were linked to the sectoral manpower requirement which is then translated into occupational and educational requirement. Data required for this stage are presented in the second half of Chapter V, the human resource account. Table XXXIX shows a complete listing of matrices, vectors, and scalars used in the model.

7.1.1 Determining Total Sectoral Final Demand

After estimating the aggregate final demand components for the target years in the previous chapter, it is necessary to allocate those forecasts among the endogenous sectors in the model. The allocation of these aggregate final demand components is determined by the base year final demand matrix.[1] So, the first step in this stage of the development of the model was to use this matrix to generate the base year direct requirements for the output of each endogenous sector per one Saudi

[1]This matrix is shown in Table LVII in Appendix B.

TABLE XXXIX

INITIALIZATION OF THE VARIABLES IN THE MANPOWER REQUIREMENT MODEL

Scalar	Description
$PC_{i,t-1}$	Private consumption of the output of Sector i in Year t-1
PC_{t-1}	Total private consumption in Year t-1
$P_{i,t-1}$	The proportion of PC used by Sector i in Year t-1
$GC_{i,t-1}$	Government consumption of the output of Sector i in Year t-1
GC_{t-1}	Total government consumption in Year t-1
$G_{i,t-1}$	The proportion of GC used by Sector i in Year t-1
$GCF_{i,t-1}$	Gross capital formation of the output of Sector i in Year t-1
GCF_{t-1}	Total gross capital formation in Year t-1
$I_{i,t-1}$	The proportion of GCF used by Sector i in Year t-1
$Exp_{i,t-1}$	The amount of export of the output of Sector i in Year t-1
Exp_{t-1}	Total export in Year t-1
$e_{i,t-1}$	The proportion of Exp exported by Sector i in Year t-1
PAG_{t-1}	The productivity of the agriculture sector in Year t-1
$POil_{t-1}$	The productivity of the oil sector in Year t-1
$PMin_{t-1}$	The productivity of the mining sector in Year t-1
$PMan_{t-1}$	The productivity of the manufacturing sector in Year t-1
GL_t	The total employment requirement in the government sector in Year t
a_1	One plus the annual rate of change in the employment of the government sector
TL_t	Total employment requirement in the private and public sectors
$PL_{i,t}$	The employment requirement in Sector i in Year t
a_2	One plus the annual rate of change in the domestic labor supply
DTL_t	The total domestic labor supply in Year t
TAL_t	The total available labor in Year t
FL_{1980}	The total number of foreign labor in Year 1980
$TRSL_t$	Total required Saudi labor in Year t
PUt_{t-1}	The productivity of the utility sector in Year t-1
$PCon_{t-1}$	The productivity of the construction sector in Year t-1
PTD_{t-1}	The productivity of the trade sector in Year t-1
PTr_{t-1}	The productivity of the transport sector in Year t-1
PFI_{t-1}	The productivity of the finance sector in Year t-1
PSE_{t-1}	The productivity of the service sector in Year t-1

Vector	Description
$[PC]_t$	10 by 1 vector represents the distribution of the private consumption of the endogenous sectors in Year t
$[P]$	10 by 1 vector represents the proportionality distribution of PC in the base year t-1, 1976
$[GC]_t$	10 by 1 vector represents the distribution of the government consumption of the endogenous sectors in Year t

TABLE XXXIX (Continued)

Vector	Description
[G]	10 by 1 vector represents the proportionality distribution of GC in the base year t-1, 1976
$[GCF]_t$	10 by 1 vector represents the distribution of the gross capital formation of the endogenous sectors in Year t
[I]	10 by 1 vector represents the proportionality distribution of GCF in the base year t-1, 1976
$[Exp]_t$	10 by 1 vector rep.resents the distribution of the export of the endogenous sectors in Year t
[e]	10 by 1 vector represents the proportionality distribution of Exp in the base year t-1, 1976
$[TFD]_t$	10 by 1 vector of total final demand in Year t
$[X^d]_t$	10 by 1 vector of total output in Year t
$[SKM_i]_{t-1}$	1 by 7 vector shows the employment requirements by occupation in Sector i in Year t-1
$[SEM_i]_{t-1}$	1 by 9 vector shows the employment requirements by education in sector i in Year t-1
$[SOV]_{t-1}$	1 by 7 vector shows the employment requirements by occupation in the government sector in year t-1
$[SEV]_{t-1}$	1 by 9 vector shows the employment requirements by education in the Government sector in Year t-1
$[FLO]_{1980}$	7 by 1 vector shows the foreign labor by occupation in Year 1980
$[TLO]_t$	7 by 1 vector shows the total employment requirements by occupation in Year t
$[RSLO]_t$	7 by 1 vector shows the required Saudi labor by occupation in Year t
$[PRSLO]_t$	7 by 1 vector shows the proportion of TRSL in each occupation in Year t
$[ASLO]_t$	7 x 1 vector shows the available Saudi labor by occupation in Year t
$[IMLO]_t$	7 by 1 vector shows the labor by occupation needed to be imported in Year t
$[LOR]_{t-1}$	10 by 1 vector of the employment requirement of a sector per unit of output in year t-1
$[PL]_{t-1}$	10 by 1 vector represents the endogenous or private sector's employment requirement in Year t-1
$[L^C]_t$	10 by 1 vector of the crude estimate of the required sectoral employment in Year t
$[L^S]_t$	10 by 1 vector of the saving in sectoral employment requirement due to increase in productivity in Year t

Matrix	Description
A_1	10 by 10 matrix of technical or direct coefficients
A_2	10 by 10 matrix of direct and indirect coefficients
A_3	10 by 10 diagonal matrix where each element on the diagonal represents the reciprocal of one plus the annual rate of change in productivity

TABLE XXXIX (Continued)

Matrix	Description
A_4	10 by 7 matrix where each row represents the proportional composition of that sector's occupation
A_5	10 by 9 matrix where each row represents the proportional composition of that sector's education
SOM_t	10 by 10 diagonal matrix where each element on the diagonal represents a sector's output in Year t
SKM_t	10 by 7 matrix where each element shows the total demand for each occupation generated within endogenous sector
SEM_t	10 by 9 matrix where each element shows the total demand for each educational level within each endogenous sector
SLM_t	10 by 10 diagonal matrix where each element on the diagonal represents the total labor of the endogenous sectors in Year t
$DIEM_t$	10 by 10 matrix of the employment generated in the row sector by the column sector for the latter to produce one unit of its output for final demand in Year t
$LORM_t$	10 by 10 diagonal matrix where the elements on the diagonal represent $[LOR]_t$
$GSKM_t$	10 by 7 matrix where each element represents the employment in each occupation in each sector per unit of final demand in Year t
DEM_t	10 by 10 diagonal matrix where the elements on the diagonal represents the column vector of the row sum of matrix $DIEM_t$
$GSEM_t$	10 by 9 matrix were each element represents the employment with each level of education in each sector per unit of final demand in Year t

Riyal in each exogenous final demand sector. One equation for each exogenous sector is needed to accomplish this task. Those equations are:

$$P_{i,t-1} = \frac{PC_{i,t-1}}{PC_{t-1}} \tag{7.1}$$

where:

$PC_{i,t-1}$ is the private consumption of the output of Sector i in Year t-1 and i = 1, . . ., 10,

PC_{t-1} is the total private consumption in Year t-1, and

$P_{i,t-1}$ is the proportion of PC used by Sector i in Year t-1.

$$G_{i,t-1} = \frac{GC_{i,t-1}}{GC_{t-1}} \tag{7.2}$$

where:

$GC_{i,t-1}$ is the government consumption of the output of Sector i in Year t-1,

GC_{t-1} is the total government consumption in Year t-1, and

$G_{i,t-1}$ is the proportion of GC used by Sector i in Year t-1.

$$I_{i,t-1} = \frac{GCF_{i,t-1}}{GCF_{t-1}} \tag{7.3}$$

where:

$GCF_{i,t-1}$ is the gross capital formation of the output of Sector i in Year t-1,

GCF_{t-1} is the total gross capital formation in Year t-1, and

$I_{i,t-1}$ is the proportion of GCF used by Sector i in Year t-1.

$$e_{i,t-1} = \frac{Exp_{i,t-1}}{Exp_{t-1}} \tag{7.4}$$

where:

$Exp_{i,t-1}$ is the amount of export of the output of Sector i in Year t-1,

Exp_{t-1} is the total export in Year t-1, and

$e_{i,t-1}$ is the proportion of Exp used by Sector i in Year t-1.

Each column in the final demand matrix represents a vector and each of the above equations show how the base year proportionality vector of P, G, I, and e is calculated respectively. Those vectors are calculated by dividing each endogenous sector i, consumption PC_i and GC_i, gross capital formation GCF_i, and exports Exp_i by the total amount of final demand absorbed by each one of the four exogenous sectors, PC, GC, GCF, and Exp, respectively. The second step in this stage was to distribute each total final demand component projected by the final demand model among the endogenous sectors according to the base year proportionality vectors obtained by the above equations. The following equations accomplish this task:

$$PC_{i,t} = PC_t \cdot P_{i,t-1} \tag{7.5}$$

$$GC_{i,t} = GC_t \cdot G_{i,t-1} \tag{7.6}$$

$$GCF_{i,t} = GCF \cdot I_{i,t-1} \tag{7.7}$$

$$Exp_{i,t} = Exp_t \cdot e_{i,t-1} \tag{7.8}$$

where:

$i = 1, \ldots, 10$ and

$t = 77, 78, \ldots, 90$.

For greater convenience and generality, it is useful to use the matrix-vector notation. Let P, G, I, and C denote the base year proportionality vectors of the private and government consumption, gross fixed capital formation, and exports, respectively. The dimensions of each vector is 10 by 1 because there are 10 endogenous sectors in the system. The above equations are rewritten in a vector format as follows:

$$[PC]_t = PC_t \cdot [P] \tag{7.5A}$$

$$[GC]_t = GC_t \cdot [G] \tag{7.6A}$$

$$[GCF]_t = GCF_t \cdot [I] \tag{7.7A}$$

$$[Exp]_t = Exp_t \cdot [e] \tag{7.8A}$$

where:

PC_t, GC_t, GCF_t, and Exp_t are scalers

and

the notations between brackets are vectors.

From now on, vectors will be presented by brackets.

The last step in this stage was to determine the total sectoral

final demand. To do this, one needs to add up the righthand side of the last four equations as follows:

$$[TFD]_t = [PC]_t + [GC]_t + [GCF]_g + [Exp]_t \qquad (7.9)$$

where:

$[TFD]_t$ is 10 by 1 vector of total final demand in Year t.

The total final demand obtained by the implementation of the above equation, (7.9), is used as an input in the third stage of the development of the model. The third stage is concerned with the projection of the future sectoral output. Thus, before moving to the second stage of the model, the assumptions made in the first stage and their validity are discussed.

There are two assumptions in the first stage of the model. The first assumption is that the final demand model developed in the last chapter project each final demand components with a reasonable degree of accuracy. The accuracy and validity of the final demand model in projecting the future value of each final demand component was tested in the previous chapter. The model proved to be reasonably accurate, statistically, in its projection and made sense economically. The second assumption is that the proportionality distribution of the final demand components in the base year will hold throughout the period covered by this research. This assumption is very strong and rigid. The main reason behind this assumption is the lack of data. The assumption might not be valid for a developed country but very well could be realistic for a developing country like Saudi Arabia. The economy of Saudi Arabia is characterized by almost total dependency on

imports for the country's needs for goods and services and on oil exports for revenue. This was the case during the past two decades and it is expected to continue in the future. Government was the major contributor to GCF in the past and it will continue to be such in the foreseeable future. During the second plan, very little change in the structure of the economy was experienced [91]. The nature and characteristics of the economy of Saudi Arabia and the use of the domestic inverse instead of the total inverse reduce considerably the severity of the second assumption. Oil exports account for more than 90 percent of total exports. This fact helped soften the severity of the second assumption with respect to constant proportionality distribution of the export component of final demand.

7.1.2 Determining Rate of Change in Labor Productivity

In this stage, labor productivity within each sector for the appropriate time periods was estimated. From those estimations, one can determine the annual rate of change in each sector labor productivity. The productivity concept used in this model is, by necessity, GDP per employee. The main reason for using sector GDP instead of sector output is that historical data for sector outputs are not available whereas sector GDP's are available. Data on sector GDP and labor from 1965 to 1980 were used to derive a historical trend on labor productivity over the same period.[1] Then, labor productivity data were used as the dependent variable and time as the independent variable to determine the appropriate rate of change in each sector's productivity.

---

[1]Data on sector GDP and labor from 1965 to 1980 were presented in Chapter III.

In order to determine the most appropriate rate of change in productivity, several times series models were developed for each sector. Those models were analyzed to determine the most appropriate model to project the productivity of each sector. The most appropriate model for each sector is determined by the same statistical criteria used in determining the most appropriate final demand model developed in the previous chapter. The reasonableness of the future change in productivity projected by the model was carefully analyzed. The linear model proved most suitable for all sectors except the utility sector. The productivity of the utility sector shows a decreasing trend. This decrease in productivity is not anticipated to continue in the future. The MOP projected that the productivity of this sector will increase by 19.5 percent over the TDP [92]. This is a very high jump when compared to the projected increase in the rest of the sectors. [See Appendix B, Table LVIII.] Because of this, the change in the productivity of the utility sector was not determined in the same way as the rest of the sectors. Instead, the second highest projected increase in productivity estimated by the MOP, that of the manufacturing sector, was considered.

The estimate of the parameters of the rest of the sectors obtained by the utilization of the linear model for each sector are shown below:[2]

$$PAG_t = 0.391 + 0.305t \tag{7.10}$$

$$POil_t = -1018.858 + 395.717t \tag{7.11}$$

---

[2]The value of 1, 2, 3, . . ., 16 were used to obtain those parameters instead of 1965, 1966, . . ., 1980 in order to reduce the size of the intercept.

$$PMin_t = -62.034 + 14.864t \quad (7.12)$$

$$PMan_t = -8.438 + 3.496t \quad (7.13)$$

$$PCon_t = -36.395 + 9.388t \quad (7.14)$$

$$PTD_t = -7.287 + 3.685t \quad (7.15)$$

$$PTR_t = 2.984 + 3.356t \quad (7.16)$$

$$PFI_t = -93.189 + 38.346t \quad (7.17)$$

$$PSE_t = -0.961 + 0.610t \quad (7.18)$$

7.1.3 Determining Sectoral Output

The third stage in the development of the model was concerned with determining the total sectoral output. The estimates of final demand computed in the first stage by Equation (7.9) were combined with the input-output direct and indirect coefficients matrix, A_2, from Table XXV to yield estimates of the future level of intermediate demand and total required output. The direct and indirect coefficients matrix, A_2, which is also called the Leontief inverse, is the core in the determination of the future sectoral output. The future sectoral outputs were obtained by multiplying the direct and indirect coefficients matrix by the total final demand vector.

$$[X^d]_t = A_2 [TFD]_t \quad (7.19)$$

where:

$[X^d]_t$ is 10 by 1 column vector of total output in Year t, and

A_2 is 10 by 10 matrix where each element in this matrix indicates the amount of the output of the row sector used as an input by the column sector in order for the latter to produce one unit of its output for final demand, reflecting the direct and indirect input requirement.

The assumptions made with respect to this stage are those inherited in the open-static/input-output techniques [37]. The most rigid and restrictive assumption is the assumption of fixed technical coefficients. This assumption means that regardless of the year, the level of output in any given sector requires a specific amount of input from the other sectors per unit of its output, and that those requirements are fixed. This assumption is not necessarily true in all cases. The validity of this assumption depends on the mobility of the economy. This assumption is very rigid for a mobile and changing economy. However, data showing a systematic variation for some or all of the technical coefficients are seldom available. Lack of data is the main reason behind this assumption with respect to this research. This is the first and only input-output table developed for Saudi Arabia. To reduce the severity of this assumption and to provide for adjustment in technology, the labor output ratios, or the reciprocal of productivity, introduced in the previous section, will change annually to reflect the change in technology.

7.1.4 Determining Employment Requirements

7.1.4.1 Sectoral Employment Requirements. In the previous sections, the annual rates of change in productivity and sectoral output were determined. In this section, they are used as inputs in determining sectoral employment. Sectoral employment was determined by two different procedures. First, the required sectoral employment for the endogenous sectors in the input-output table were determined by linking sectoral employment to sectoral output. Second, the required sectoral employment for the government sector was determined by assuming an annual rate of change in the government employment.

The first step in determining the sectoral employment was to determine the endogenous sector's employment. This was done by translating the direct and indirect sector output requirement into demand for employment within sectors. Total employment in each sector was related to its total output and expressed in terms of employment output ratios. The employment output ratio is calculated by dividing employment in each sector by its output as follows:

$$[LOR]_{t-1} = [PL]_{t-1}/[x^d]_{t-1} \tag{7.20}$$

where:

$[LOR]_{t-1}$ is 10 by 1 vector represents the sectoral employment requirements per unit of output in Year t-1 and

$[PL]_{t-1}$ is 10 by 1 vector represents the endogenous or private sector's employment in Year t-1.

If one assumes a constant employment output ratio, then, with no further refinement, one can obtain a crude estimate for sectoral employment. The employment output ratio vector is obtained by the above

equation and a new set of sectoral output. The new sectoral employment vector can be determined as follows:

$$[L^C]_t = SOM_t\ [LOR] \qquad (7.21)$$

where:

SOM_t is 10 by 10 diagonal matrix where each element on the diagonal represents the sector output in Year t and

$[L^C]_t$ is 10 by 1 vector represents the crude estimate of the sectoral employment requirements in Year t.

The sectoral employment determined by the above equation attempts to overestimate the labor requirement in each sector. The reason for the overestimation is the assumption made with respect to [LOR]. However, the estimate of $[L^C]_t$ can be used as an upper limit on the sectoral employment requirement.

The assumption of constant employment output ratio is very rigid and must be relaxed in order to produce a more reasonable estimate of $[PL]_t \cdot [LOR]$ in the reciprocal of productivity, and the annual rate of change in productivity was determined in Section 7.1.2. The annual change in productivity was incorporated into equation 7.21 to relax the assumption and produce a more reasonable estimate of $[PL]_t$.

$$[PL]_t = A_3\ SOM_t\ [LOR]_{t-1} \qquad (7.22)$$

where:

A_3 is 10 by 10 diagonal matrix where each element in the diagonal represents the reciprocal of one plus the annual change of productivity

The saving in labor due to the increase in productivity can be determined by subtracting $[PL]_t$ from $[L^C]_t$.

$$[L^S]_t = [L^C]_t - [PL]_t \tag{7.23}$$

where:

$[L^S]_t$ is a 10 by 1 vector representing the saving in sectoral employment requirement in Year t.

The second step in determining the sectoral employment was to determine the government sector employment. Government employment is assumed to increase by a specific percentage annually.

$$GL_t = a_1 GL_{t-1} \tag{7.24}$$

where:

GL_t is the total employment in the government sector in Year t

a_1 is one plus the annual rate of change in employment in the government sector.

The total labor requirement can be determined by adding Equation (7.22) and Equation (7.24).

$$TL_t = \sum_{i=1}^{10} PL_{i,t} + GL_t \tag{7.25}$$

where:

TL_t is the total labor requirement in Year t.

7.4.1.2 Occupational and Educational Employment Requirements. The projected total sectoral manpower requirements determined by Equation (7.22), the base year sector by occupation matrix, and the base year

sector by education matrix were utilized to project the future manpower requirements in the form of occupational and educational requirements. The base year sector by occupation and sector by education matrices are shown in Table XXIX and Table XXXI, respectively, in Chapter V. The first 10 rows of these tables represent the distribution of occupational and educational level of the endogenous sectors while the last row represents that of the government sector. Equation (7.26) and (7.27) display this calculation for the endogenous sectors whereas Equations (7.30) and (7.31) display it for the government sector.

$$SKM_t = [SKM_i]_{t-1} (PL_{i,t}/PL_{i,t-1}) \tag{7.26}$$

$$SEM_t = [SEM_i]_{t-1} (PL_{i,t}/PL_{i,t-1}) \tag{7.27}$$

where:

SKM_t is 10 by 7 matrix where each element shows the total demand for each occupation generated within each sector by a certain pattern of final demand expenditure in Year t,

$SKM_{i,t-1}$ is 1 by 7 row vector where each element shows the total demand for each occupation in Sector i in Year t-1. i = 1, . . ., 10,

$PL_{i,t}$ is total labor in the Private Sector i in Year t,

$PL_{i,t-1}$ is total labor in the Private Sector i in Year t-1,

SEM_t is 10 by 9 matrix where each element shows the total demand for each educational level within each sector by certain patterns of final demand expenditure in Year t, and

$SEM_{i,t-1}$ is 1 by 9 vector where each element shows the total

demand for all educational levels in Sector i in Year t-1. i = 1, . . ., 10.

SKM and SEM matrices were obtained by following a different procedure. The base year occupational labor coefficient's matrix and the base year educational labor coefficient's matrix, shown in Table XXVIII and Table XXX, respectively, in Chapter V, were used with the labor by sector vector to determine SKM and SEM.

$$SKM_t = SLM_t \cdot A_4 \tag{7.28}$$

$$SEM_t = SLM_t \cdot A_5 \tag{7.29}$$

where:

SLM_t is 10 by 10 diagonal matrix where each element on the diagonal represents the total labor of the row sector in Year t,

A_4 is 10 by 7 matrix where each row represents the proportional composition of that sector occupation, each row in the matrix must sum to 1, and

A_5 is 10 by 9 matrix where each row represents the proportional composition of that sector education, each row in the matrix must sum to 1.

The Government sector equations are:

$$[SOV]_t = [SOV]_{t-1} (GL_t/GL_{t-1}) \tag{7.30}$$

$$[SEV]_t = [SEV]_{t-1} (GL_t/GL_{t-1}) \tag{7.31}$$

where:

$[SOV]_t$ is 1 by 7 row vector where each element shows the total

demand for each occupation generated within the Government sector in Year t and

$[SEV]_t$ is 1 by 9 vector where each element shows the total demand for each educational level within the Government sector in Year t.

There are two assumptions made with respect to this stage. The first assumption is that the elements of matrices A_4 and A_5 are fixed over a substantial range of employment variation. Changing the proportionality of the elements of those matrices would require considerable research. A survey must be conducted in order to update those matrices. This assumption is very similar to the assumption of fixed technical coefficients made in the previous stage. The second assumption is that the productivities of the different occupational group and educational level in a sector are the same. In order to eliminate this assumption, one needs to know the percentage of the output of each sector produced by each occupational group and each educational level. This type of detailed information is not yet available for most of the developed countries, much less for a developing country like Saudi Arabia.

7.1.4.3 Analysis of the Employment Requirements. The analysis of the manpower demand was conducted in two stages. In the first stage, the required manpower by occupational and educational level within each sector per one unit of deliveries to final demand were determined. This was accomplished by generalizing Equations (7.28) and (7.29). The generalization of those equations was accomplished in two steps. First, each row element in $[LOR]_t$ was multiplied by its corresponding row in A_2.

$$DIEM_t = LORM_t \cdot A_2 \qquad (7.32)$$

where:

$DIEM_t$ is 10 by 10 matrix where each element shows the employment generated in the row sector by the column sector for the latter to produce one unit of its output for final demand in Year t and

$LORM_t$ is 10 by 10 diagonal matrix where the elements on the diagonal represent $[LOR]_t$.

Each column of $DIEM_t$ represents the employment generated by that column sector in all row sectors for the column sector to produce one unit of its final demand output. This expresses the employment effects of the backward linkages. In turn, each row sector of $DIEM_t$ represents the employment generated in that row sector by all other column sectors. This expresses the employment effect of the forward linkages. The element on the diagonal of $DIEM_t$ represents the direct employment in each sector per one unit of that sector's output transferred to final demand. The row vector of column totals of $DIEM_t$ gives the total employment per unit of final demand output generated <u>by</u> each sector, while the column vector of row totals gives the total employment per one unit of final demand output generated <u>in</u> each sector.

The second step was to form a diagonal matrix by diagonalizing the column vector of row totals of Matrix $DIEM_t$ and multiplying it by Matrices A_4 and A_5, respectively.

$$GSKM_t = DEM_t \cdot A_4 \qquad (7.33)$$

where:

$GSKM_t$ is 10 by 7 matrix where each element represents the

employment in each occupation in each sector per unit of final demand in Year t and

DEM_t is 10 by 10 diagonal matrix where the elements on the diagonal represent the column vector of row totals of Matrix $DIEM_t$ in Year t.

$$GSEM_t = DEM_t \cdot A_5 \tag{7.34}$$

where:

$GSEM_t$ is 10 by 9 matrix where each element represents the employment of each level of education in each sector per unit of final demand in Year t.

The second stage in the analysis of the employment demand determines whether or not the Saudi population can supply the required manpower by occupation to achieve the projected increase in output. The MOP estimated that the domestic labor supply will increase by 1.99 percent annually from 1980 to 1985 [92]. The same percentage increase was assumed to continue through the last part of the 1980's. The total domestic labor supply was calculated by the following equations:

$$DTL_t = a_2 \cdot DTL_{t-1} \tag{7.35}$$

where:

DTL_t is a scalar denoting the total domestic labor in Year t and

a_2 is a scalar denoting one plus the annual increase in domestic labor supply

The total number of labor available was calculated as:

$$TAL_t = TDL_t + FL_{1980} \tag{7.36}$$

where:

TAL_t is a scalar denoting the total number of labor available in Year t and

FL_{1980} is a scalar denoting the total number of foreign labor in 1980.[3]

TAL_t is compared to TL calculated in Equation (7.25) to determine if additional laborers are needed to be imported. This comparison is very general and the available labor by sector and occupation needs to be compared to the required labor by occupation. The following equations show those comparisons and determine the number of workers needed to be imported.

$$[RSLO]_t = [TLO]_t - [FLO]_{1980} \tag{7.37}$$

where:

$[RSLO]_t$ is 7 by 1 vector representing the required Saudi labor by occupation in Year t,

$[TLO]^4_t$ is 7 by 1 vector representing the total required labor by occupation in Year t, and

$[FLO]_{1980}$ is 7 by 1 vector representing the foreign labor by occupation in 1980.

$$[PRSLO]_t = \frac{1}{TRSL_t}[RSLO]_t \tag{7.38}$$

---

3 The imported laborers are assumed to experience no change, with respect to its total, in distribution among sector and distribution among occupation.

4This vector is obtained by summing the column of Matrix SKM calculated by Equation (7.28) and adding to it the vector [SOV] calculated by Equation (7.30).

where:

$[PRSLO]_t$ is 10 by 1 vector representing the proportion of TRSL in each occupation in Year t and

$TRSL_t$ is a scaler denoting the total required Saudi labor in the private and public sectors in Year t.

$$[ASLO]_t = DTL_t \cdot [PRSLO]_t \tag{7.39}$$

where:

$[ASLo]_t$ is 7 by 1 vector representing the available Saudi labor by occupation in Year t.

$$[IMLO]_t = [RSLO] - [ASLO]_t \tag{7.40}$$

where:

$[IMLO]_t$ is 7 by 1 vector representing the number of workers by occupation needed to be imported in Year t.

The analysis of employment is very important for several reasons. First, it provides a highly detailed description of the structure of demands generated for each occupational and educational level by a specific pattern of final demand. Second, it identifies those occupations and educations most strongly tied to specific sectors. Third, it identifies those sectors and occupations where foreign workers are dominant.

7.2 Testing the Accuracy of the Model

Since the period from 1977 to 1980 is now past, the estimates of the required manpower by sector generated by the model presented in the previous section were matched against actual data to test the accuracy of the model. Test of the model estimates of the required manpower

by sector is very important because the model will generate accurate occupational and educational manpower requirements only to the degree it generates actual sectoral manpower requirements. The total employment generated within each sector by the implementation of the model must be checked against actual data for the years 1977 to 1980. The main reason behind the choice of this period is that actual data for this time is available.

The accuracy of the model deals with its predictive error. This error is mainly the difference between the actual and predicted values. The main question to be answered is to what extent did the model succeed in predicting the actual manpower requirements by sector. Usually, statistical techniques are used to help in answering this question. First, the model was used to project manpower requirements by sector for the test period, 1977 to 1980. The results obtained by the implementation of the model are shown in Table XL. Second, the difference between the actual and predicted manpower requirements by sector was calculated and is evaluated. Third, a statistical technique was used to evaluate and test the significance of these differences on the overall performance of the model.

The chi-square "goodness of fit" test was selected to test the significance of the difference between the actual manpower requirement by sector and that obtained as a result of the implementation of the model. This test is an extremely useful type of test and is frequently used to evaluate the applicability of a mathematical model under certain conditions. The chi-square test basically provides a probability basis for testing the variation between the actual and the predicted value.

TABLE XL

THE PROJECTED MANPOWER REQUIREMENTS FOR THE ENDOGENOUS SECTORS FOR THE TEST PERIOD (1977-1980) (IN THOUSANDS)

	Sector	1977	1978	1979	1980
1.	Agriculture	662.5	643.4	622.9	550.8
2.	Oil	30.4	27.4	35.3	43.9
3.	Mining	4.9	5.7	5.6	6.1
4.	Manufacturing	93.4	99.7	97.1	108.0
5.	Utility	22.7	24.5	25.0	28.6
6.	Construction	249.0	296.0	291.4	320.6
7.	Trade	215.2	241.9	268.1	302.7
8.	Transport	161.1	171.8	187.6	234.4
9.	Finance	20.3	23.5	26.3	32.1
10.	Service	344.9	387.4	422.1	518.8
	Totals	1805.3	1921.3	1981.4	2146.0

The value of this test is calculated as:

$$X^2 = \sum_{t=1}^{N} \frac{(P_t - A_t)}{A_t} \qquad (7.41)$$

where:

P_t is the projected manpower requirement in Year t,

A_t is the actual manpower requirement in Year t, and

N is the number of observations, N = 4.

One can see that as the difference between P_t and A_t gets smaller, the value of X^2 will get smaller. This indicates that the smaller the value of X^2, the more accurate the performance of the model in predicting future manpower requirements by sector. In other words, a small value of X^2 leads to the acceptance of the null hypothesis, while a large value leads to the rejection of the hypothesis.[5]

The chi-square statistic, X^2, for each sector was calculated for the test period. The value of the calculated, X^2, and the decision to accept or reject the null hypothesis, based on the decision rules for different significance levels with (n-1) degree of freedom, are shown in Table XL1. Based on the results obtained from the utilization of the chi-square, X^2, test shown in Table XL1, the null hypothesis was accepted at the one percent level with respect to all sectors. Only the projections of the construction and service sectors were rejected at the five and ten percent levels of significance. Based on the above summary, one cannot reject the null hypothesis merely

---

[5]Two hypotheses were defined in Chapter I, p. 11. Here, we are concerned only with the second hypothesis because the first was tested in Chapter VI.

TABLE XL1

THE CHI-SQUARE STATISTIC, X^2, AND THE DECISION TO REJECT OR NOT REJECT THE SECOND HYPOTHESIS BASED ON THE TEST PERIOD (1977-1980)

Sector	Calculated X^2	At 1 Percent If $X^2 > 11.3449$, Reject H_o If $X^2 < 11.3449$, Do Not Reject H_o	At 5 Percent If $X^2 > 7.81473$, Reject H_o If $X^2 < 7.81473$, Do Not Reject H_o	At 10 Percent If $X^2 > 6.25139$, Reject H_o If $X^2 < 6.25139$, Do Not Reject H_o
Agriculture	3.99795	Do not reject	Do not reject	Do not reject
Oil	2.52048	Do not reject	Do not reject	Do not reject
Mining	0.30508	Do not reject	Do not reject	Do not reject
Manufacturing	3.42423	Do not reject	Do not reject	Do not reject
Utility	0.67619	Do not reject	Do not reject	Do not reject
Construction	9.56791	Do not reject	Reject	Reject
Trade	0.88268	Do not reject	Do not reject	Do not reject
Transport	3.40654	Do not reject	Do not reject	Do not reject
Finance	0.45362	Do not reject	Do not reject	Do not reject
Services	9.77078	Do not reject	Reject	Reject

because only two sectors out of ten were rejected at some level of significance.

A closer look at the projected sectoral manpower requirements reveals that most are higher than the actual manpower requirements. This was anticipated because the input-output model usually over-estimated the manpower requirement.

The result of the hypothesis test suggests the validity of the model in projecting sectoral manpower requirements. But this does not necessarily mean that the future sectoral manpower requirements (1981 to 1990), to be obtained by the implementation of the model, with as accurate as that of the test period. In reality, the accuracy of the results obtained by the model depends to a large extent on the validity of the assumptions made with respect to the independent variables in the final demand model and the assumptions made in each stage of the manpower requirement model. As mentioned in the previous chapter, four different sets of estimations of the independent variables were used. The major objective was to reduce reliance on only one source; the future is multiple and several futures are possible. Most of the assumptions made with regard to the manpower requirements model were made to overcome the inexistence of data.

7.3 The Implementation of the Model

In the preceding sections, the manpower requirement model was developed and empirically tested. Once the model has been developed and empirically tested, the sectoral manpower requirement projections, occupational manpower requirement projections, and educational manpower requirement projections can be made. Data needed for the implementation

of the model were presented in Chapters III, VI, and Appendix B. Because of differences between the sectoral productivity obtained as a result of the implementation of the second stage of the manpower requirement model and that furnished by the ministry of planning, each scenario was run twice.[6] In the first run, the productivity obtained by the model was used while in the second run, the productivity furnished by the MOP was used.

As a result of the implementation of the model, four major pieces of information were obtained. The first is the total manpower requirements, exogenous and endogenous sectors, of the four scenarios under the two sets of productivity. Those totals were compared to each other, and an upper and lower unit on total manpower requirements for the coming years were set. The second item of information is the sectoral manpower requirements. The third and fourth are the sectoral manpower requirement by occupation and by education, respectively. Analysis of this information helps in pinpointing the sector which has the greatest influence on the demand for an individual occupation and education, as well as helping in determining whether or not the Saudi population can supply the required increase in total labor demand.

7.3.1 Manpower Requirements

What is meant by manpower requirements is the manpower requirements for the endogenous and exogenous (Government) sectors. Considering total manpower requirement first, Figures 2 and 3 show the projection of the total manpower requirements projected by the four scenarios

---

[6]For comparison of the two sets of productivity, see Table LVIII in Appendix B.

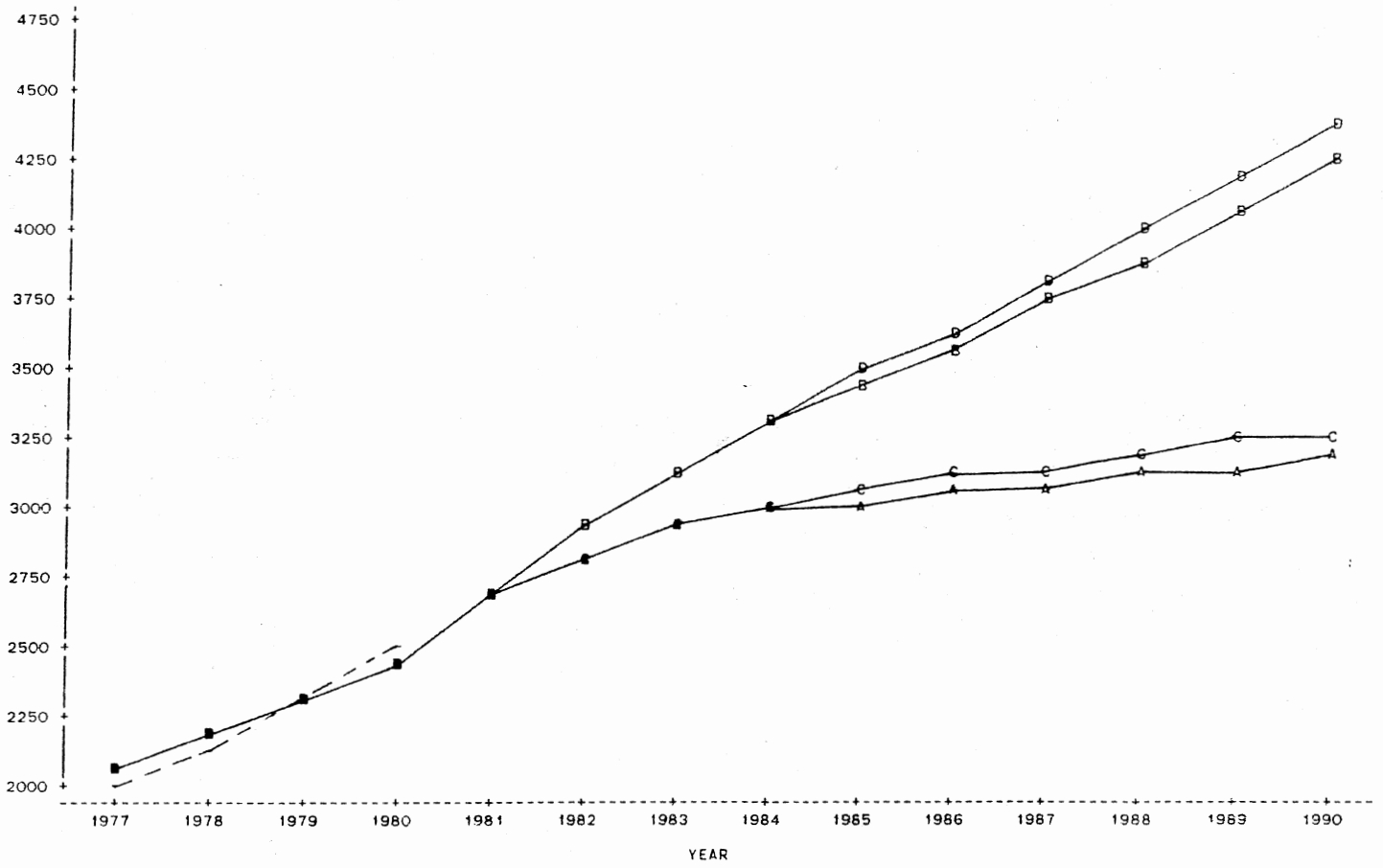


Figure 2. The Projections of the Total Manpower Requirements of the Four Scenarios Under the First Set of Productivity

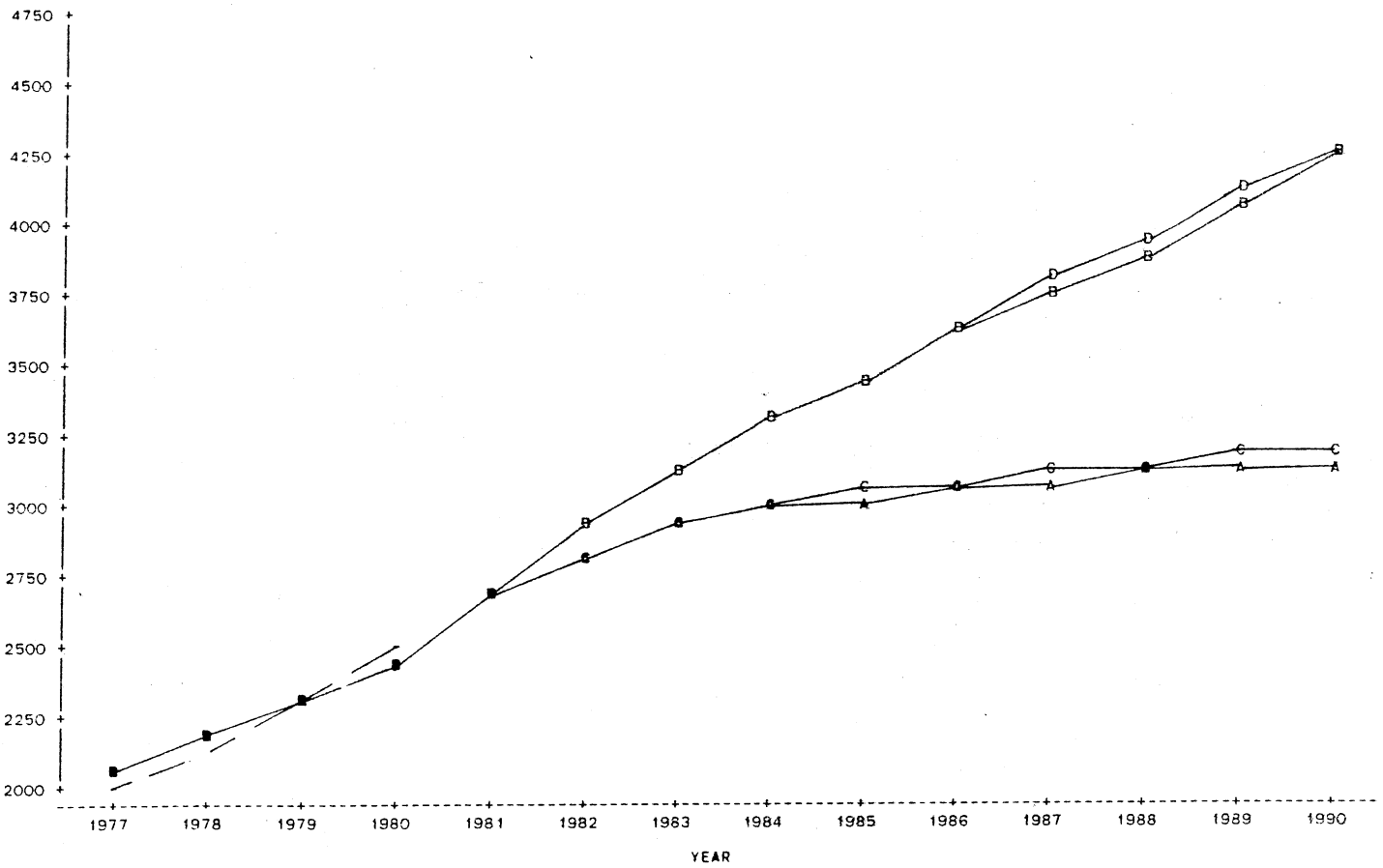


Figure 3. The Projections of the Total Manpower Requirements of the Four Scenarios Under the Second Set of Productivity

under the two sets of productivity. Figure 2 shows the actual and projected total manpower requirements for the four scenarios using the rate of change in productivity obtained by the manpower model while Figure 3 shows the actual and projected values resulting from using the MOP rate of change in productivity.[7]

Several points are noted in comparing the two figures. In both Figures 2 and 3, Scenarios A and C present the lower limit for the total required manpower during the 1980's while Scenarios B and D present the upper limit. Scenario C gives a higher estimate than Scenario A. In 1985 and 1990 Scenario C forcasts total manpower requirement of about 20,906 and 66,954 workers higher than that of Scenario A in the same two years, respectively, under the manpower productive model. Using the MOP productivity, Scenario C forecasts of total manpower in 1985 and 1990 are about 31,391 and 118,959 workers higher than that forecast by Scenario A in the same years. The differences between the projections of the two Scenarios A and C, under both sets of productivity, grow wider with time. The same is true for the projections of Scenarios B and D. The increases in differences are attributed to the differences in the anticipated rates of change in the independent variables set by the different scenarios. One has to be cautious not to draw conclusions based on those comparisons because only total manpower requirements are compared here. As this type of comparison is very general, a more specific comparison is needed in order to draw a better

---

[7]From now on, the rate of change in productivity estimated by the second stage of the manpower requirement model will be called the first set of productivity, while that estimate by the MOP will be called the second set of productivity.

conclusion about the projections of the scenarios under the two sets of productivity.

Table XLII gives a summary comparison of the sectoral manpower requirements projected by the four scenarios under the two sets of productivity in Years 1985 and 1990. This comparison is more detailed than the comparison of total manpower requirements. To draw a better conclusion from this table, one needs to compare the two rates of change in productivity first, then moves to the comparison of the sectoral employment requirement of each scenario under the two sets of productivity. As seen from Table LVII in Appendix B, the rate of increase in sectoral productivity estimated by the second stage of the manpower requirements model is higher than that estimated by the MOP with respect to five sectors: oil, mining, construction, finance, and services, while the MOP estimate is higher for the rest of the sectors except the utility sector where the two estimates are the same. From this comparison, one can conclude that the four scenarios under the first set of productivity will give a higher estimate of the required manpower in those sectors where it estimates a lower rate of increase in productivity than that estimated by the second set of productivity. The required manpower in the utility sector of each scenario under the two sets of productivity are the same.

Table XLII reveals that with the second set of productivity, employment in the oil, mining, construction, finance, service, and Government[8] sectors in all scenarios increases during the fourth

---

[8]Government sector is an exogenous sector and its employment is projected to increase by about 5.2 percent annually.

TABLE XLII

COMPARISON OF THE SECTOR PROJECTIONS OF THE FOUR SCENARIOS UNDER THE TWO SETS OF PRODUCTIVITY IN 1985 AND 1990 (IN THOUSANDS)

	Productivity Model								MOP Productivity							
	A		B		C		D		A		B		C		D	
Sector	1985	1990	1985	1990	1985	1990	1985	1990	1985	1990	1985	1990	1985	1990	1985	1990
Agriculture	737.574	795.768	912.746	1276.151	691.418	690.439	831.641	1035.792	628.778	578.322	778.112	927.440	589.430	501.775	708.970	752.760
Oil	35.807	35.225	35.370	34.610	39.764	43.475	43.850	52.997	41.270	46.794	40.767	45.977	45.831	57.753	50.540	70.403
Mining	8.995	8.536	10.485	12.291	9.076	8.818	10.561	12.449	10.255	11.095	11.954	15.976	10.348	11.470	12.040	16.182
Manufacturing	126.866	119.716	142.741	160.474	132.625	134.361	151.684	183.668	111.570	92.587	125.530	124.109	116.633	103.913	133.395	142.047
Utility	33.487	27.921	37.890	37.870	34.822	30.961	39.917	42.517	33.487	27.921	37.890	37.870	34.822	30.961	39.917	42.517
Construction	411.701	389.166	478.241	556.254	417.938	408.895	485.071	575.016	469.375	505.836	545.235	723.017	476.485	531.472	553.023	747.403
Trade	366.446	360.117	428.189	521.657	366.581	362.769	427.495	512.582	351.227	330.826	410.406	479.226	351.356	333.263	409.741	470.891
Transport	254.419	241.965	274.573	296.024	274.318	299.982	308.864	382.923	223.987	187.542	241.730	229.442	241.505	224.759	271.919	296.795
Finance	40.919	38.803	46.199	52.476	42.400	42.425	48.649	58.126	48.821	55.235	55.120	74.697	50.567	60.391	58.043	82.741
Services	584.324	558.249	654.919	742.372	612.564	630.295	699.360	858.575	686.204	769.986	769.107	1023.812	719.368	869.246	821.297	1184.070
Government	421.526	553.538	421.526	553.538	421.526	553.538	421.526	553.538	421.526	553.538	421.526	553.538	421.526	553.538	421.526	553.538
Total	3022.061	3129.004	3442.879	4243.717	3043.032	3195.958	3469.618	4268.183	3026.497	3159.579	3437.374	4235.101	3057.888	3278.537	3430.406	4359.340

development plan, while that of the rest of the sectors decreases except those of Scenario D. One can conclude that the increase in productivity due to change in technology is too low to meet the required increase in final demand with respect to Scenario D. This is the reason behind the large increase in total labor requirement projected by this scenario. The same is true under the first set of productivity. Scenario A under the first set of productivity projected a decrease in the employment in all sectors except that of the agricultural sectors where an increase of 58,194 new jobs is anticipated during the period from 1985 to 1990. This is in conflict with what the MOP anticipated would happen [92]. The main reason for this conflict is that the annual change in productivity estimated by the model is low compared to the projected increase in final demand for the agriculture sector products. The MOP expected the employment in the agricultural sector to decrease from 598,800 workers in 1980 to 528,800 workers in 1985 [92]. The manpower requirement model with the MOP estimations of the increase in productivity in the agriculture sector and the increase in the independent variables in the final demand model, Scenario A, projected the manpower requirements in 1985 in the agricultural sector to be 628,778 workers, or about 19 percent higher than what the MOP expected. Scenario B under the first set of productivity projected an increase in the employment of all sectors except that of the oil and utility sectors. Scenario C, on the other hand, projected an increase in employment in the agriculture, oil, manufacturing, transport, finance, and service sectors and a decrease in employment in the rest. According to the estimations of Scenarios A and B under the first set of productivity, employment in the oil sector will decline slightly but the estimations of Scenarios C and

D reveal the opposite, i.e., increases in employment. This conflict in estimations of the employment in the oil sector was anticipated because Scenarios A and B estimate about 2.4 and 2.0 percent in increase in WOC while that of Scenario C and D estimated about 4.6 and 6.6 percent increase in WOC, respectively. The increase in WOC will have a considerable effect on employment in the oil sector because the export of Saudi Arabia depends on WOC and the country's oil exports account for more than 90 percent of the total exports.

Next, occupational and educational requirements during the 1980's are discussed. Here, attention is focused on the total employment requirements by occupational and educational level estimated by the four scenarios under the two sets of productivity estimates. Table XLIII shows a summary comparison of the requirements for manpower by occupation estimated for the years 1985 and 1990 by the four scenarios under the two sets of productivity estimates. The table reveals that the estimated demands for all occupations in all scenarios under the two sets of productivity estimates increase during the period from 1985 to 1990, with the exception of the agriculture and production occupations. Scenario A, under the first set of productivity estimates, projects a slight decline in demand for production workers, while Scenarios A and C, under the second set of productivity estimates, project a decline in the demand for agriculture workers. The estimated decline in agricultural workers comes as a result of the projected decline in the agricultural sector employment of those scenarios which was discussed in the preceding paragraph. More than 58 percent of the workers in the agriculture sector are classified as agricultural workers in the base year, 1976. Thus, a slight change in the employment in this sector

TABLE XLIII

COMPARISON OF THE OCCUPATIONAL PROJECTIONS OF THE FOUR SCENARIOS UNDER THE TWO SETS OF PRODUCTIVITY IN 1985 AND 1990

	Model Productivity								MDP Productivity							
	A		B		C		D		A		B		C		D	
	1985	1990	1985	1990	1985	1990	1985	1990	1985	1990	1985	1990	1985	1990	1985	1990
Professional & Technical	341.241	366.259	374.589	453.848	348.150	385.398	385.398	479.577	359.084	404.567	394.160	502.741	367.257	429.352	407.008	540.119
Administrative & Managerial	65.331	67.899	73.115	88.398	66.492	74.989	74.914	92.363	66.210	70.238	74.010	91.074	67.506	74.071	76.027	96.375
Clerical & Related Workers	274.335	299.436	301.555	371.200	277.685	308.434	306.666	381.683	274.727	302.081	301.583	372.808	278.520	313.426	307.409	387.674
Sales Workers	335.168	345.764	383.871	474.337	335.711	348.751	384.141	468.921	327.750	332.447	374.414	451.151	328.993	338.702	375.918	452.809
Service Workers	387.541	405.440	428.563	512.854	396.944	429.954	443.223	548.721	412.194	457.961	455.923	581.392	423.070	490.602	472.912	630.781
Agriculture Workers	444.146	479.033	547.834	763.195	417.426	418.152	500.822	623.666	353.588	353.588	470.019	561.594	358.630	309.732	430.653	460.770
Production & Related Workers	1174.299	1155.173	1333.348	1579.886	1200.621	1235.418	1373.452	1673.250	1205.197	1238.697	1367.265	1674.341	1233.912	1322.642	1411.079	1790.812
TOTAL	3022.064	3124.004	3442.879	4243.717	3043.032	3195.958	3468.618	4268.183	3026.497	3159.579	3437.374	4235.101	3057.886	3278.537	3480.456	4359.340

will have noticeable effects on the employment of the agricultural occupation.

Table XLIV containes a summary comparison of the requirements for manpower by educational level estimated for the years 1985 and 1990 by the four scenarios under the two sets of productivity estimates. From the table, one can see that the estimated demands for workers possessing all levels of education in all scenarios under the two sets of productivity estimates increases during the period from 1985 to 199, except that of workers who know only how to read and write and those who are illiterate. Scenario A, under the first set of productivity estimates, projects a decline in the demand for workers who know only how to read and write while Scenarios A, and C, under the second set of productivity estimates, project a decline in the demand for Illiterate Workers. The projected slight declines in the demand for workers who know how to read and write only comes as a result of the decline in the demand for production workers. Based on this, one can say that the majority of production workers are literate. On the other hand, the decline in the demand for illiterate workers in scenarios A and C under the second set of productivity estimate corresponds to the decline in the deamand for agricultural workers. This indicates that the majority of the workers in the agricultural sector in Saudi Arabia are illiterate. The demand for illiterate workers constitutes more than 30 percent of the total labor demand, while that of the illiterate workers and workers who read and write only, constitute more than 55 percent of the total demand for labor. The projected total demand for labor could be lower by increasing the productivity of the workers through education.

TABLE XLIV

COMPARISON OF THE EDUCATIONAL PROJECTIONS OF THE FOUR SCENARIOS UNDER THE TWO SETS OF PRODUCTIVITY IN 1985 AND 1990

	Model Productivity								MOP Productivity							
	A		B		C		D		A		B		C		D	
Educational Level	1985	1990	1985	1990	1985	1990	1985	1990	1985	1990	1985	1990	1985	1990	1985	1990
Advanced Studies	24.488	26.531	26.643	32.193	25.063	28.009	27.556	34.440	25.906	29.568	28.215	36.147	26.567	31.518	29.264	39.184
University Degree	185.421	189.579	211.338	258.402	187.512	195.470	214.458	263.501	187.523	195.310	212.977	262.604	190.382	205.038	217.392	275.027
Some University	88.908	95.738	96.754	116.203	91.027	101.106	100.215	124.531	92.763	104.150	101.034	127.169	95.095	110.713	104.844	137.512
Technical High School	161.117	177.371	178.106	222.530	162.089	180.246	179.516	224.084	161.647	179.334	178.154	222.521	163.143	184.777	180.451	229.093
General High School	234.578	248.966	257.416	308.643	240.032	262.879	266.296	329.641	238.971	259.753	262.321	322.849	244.675	275.234	271.576	346.425
Intermediate School	309.579	339.432	336.835	410.713	315.915	353.586	345.436	430.912	319.906	362.130	348.205	439.882	326.035	380.099	357.922	466.584
Primary School	270.208	282.764	299.035	357.768	276.180	298.363	308.352	380.114	282.447	309.379	312.684	392.825	289.096	328.804	323.063	421.450
Read & Write	835.872	832.393	960.832	1160.834	846.561	863.436	975.616	1188.707	846.050	859.699	970.385	1198.503	859.131	903.257	989.032	1239.293
Illiterate	911.959	936.296	1075.993	1376.515	899.624	912.936	1051.264	1292.352	871.363	850.343	1023.485	1248.708	863.846	859.197	1006.947	1204.905
TOTAL	3022.064	3129.004	3442.879	4243.717	3043.032	3195.958	3468.618	4288.183	3026.497	3159.579	3437.374	4235.101	3057.888	3278.637	3480.406	4359.340

7.3.2 Analysis of Manpower

The need for manpower analysis is evidenced from the projected manpower requirements presented in the previous section. The analysis conducted in this section provides a highly detailed description of the structure of demands generated for each occupational and educational level under the two sets of productivity estimations. It identifies those occupational and educational levels most strongly tied to specific sectors. Economic as well as educational planners will benefit from this analysis because it singles out those secotrs and occupations where foreign workers dominate.

The analysis of the manpower requirements will be conducted through the determination of the employment generated by a sector in all other sectors for that sector to produce one unit of its output for final demand. Table XLV shows the direct and indirect employment per unit of deliveries to final demand under the first set of productivity estimates. Each column in this table indicates the employment generated by the column sector in all row sectors for the column sector to produce one unit of its output for final demand. By the same token, each row in this table indicates the employment generated in the row sector by all column sectors, each producing one unit of its output for final demand.

The elements on the diagonal of this table represent the direct employment per unit of deliveries to final demand. For example, in 1985, for each unit of the agricultural sector produced for final demand, about 22.52237 workers are generated in this sector. This number decreases to 17.89104 in 1990. This is a healthy sign because it means that the productivity of the workers in this sector is increasing through adaption to new technology. Sector number 2, the oil sector

TABLE XLV

THE DIRECT AND INDIRECT EMPLOYMENT PER ONE MSR DELIVERIES TO FINAL DEMAND UNDER THE FIRST SET OF PRODUCTIVITY IN 1985 AND 1990

Sector	Year	Agriculture	Oil	Mining	Manufacturing	Utility	Construction	Trade	Transport	Finance	Service
Agriculture	1985	22.52237	0.00045	0.00090	0.00135	0.00202	0.00067	0.00067	0.01597	0.00022	0.00045
	1990	17.89104	0.00036	0.00071	0.00107	0.00161	0.00054	0.00054	0.01268	0.00018	0.00036
Oil	1985	0.00068	0.13204	0.00074	0.00074	0.00578	0.00101	0.00034	0.00331	0.00020	0.00231
	1990	0.00059	0.11456	0.00064	0.00064	0.00502	0.00087	0.00030	0.00287	0.00017	0.00201
Mining	1985	0.00002	0.00111	0.69704	0.00334	0.00198	0.03033	0.00024	0.00339	0.00023	0.00049
	1990	0.00001	0.00082	0.51426	0.00246	0.00146	0.02237	0.00018	0.00250	0.00017	0.00036
Manufacturing	1985	0.00486	0.01756	0.13938	2.78958	0.08369	0.06794	0.00831	0.04932	0.00377	0.04799
	1990	0.00368	0.01330	0.10560	2.11344	0.06340	0.05147	0.00630	0.03737	0.00286	0.03636
Utility	1985	0.00017	0.00702	0.08561	0.02753	5.60994	0.02034	0.00975	0.01850	0.00624	0.03751
	1990	0.00011	0.00468	0.05704	0.01834	3.73773	0.01355	0.00650	0.01233	0.00416	0.02499
Construction	1985	0.00024	0.00837	0.01372	0.04759	0.05498	2.14214	0.01238	0.22791	0.01215	0.01606
	1990	0.00018	0.00617	0.01012	0.03511	0.04057	1.58049	0.00913	0.16815	0.00897	0.01185
Trade	1985	0.02612	0.00758	0.15837	0.24141	0.26456	0.11270	3.33019	0.14892	0.01314	0.12273
	1990	0.01990	0.00578	0.12062	0.18387	0.20150	0.08583	2.53641	0.11342	0.01001	0.09348
Transport	1985	0.00171	0.07110	0.15242	0.09326	0.33887	0.08192	0.14805	3.52712	0.02985	0.06739
	1990	0.00135	0.05618	0.12045	0.07369	0.30728	0.06473	0.11699	2.78714	0.02359	0.05325
Finance	1985	0.00118	0.00890	0.01216	0.02886	0.38758	0.05132	0.01939	0.03646	0.56642	0.02545
	1990	0.00090	0.00674	0.00921	0.02187	0.02935	0.03888	0.01469	0.02762	0.42912	0.02004
Service	1985	0.00130	0.17352	0.09953	0.10812	0.13340	0.06644	0.04012	0.08546	0.00938	26.12094
	1990	0.00100	0.13356	0.07661	0.08322	0.10268	0.05114	0.03088	0.06578	0.00722	20.10574

shows that about 0.13204 and 0.11456 workers are generated in this sector in order for it to produce one unit of its ouput for final demand. A comparison between the employments generated in each sector by the column sector indicates that the oil sector is a capital intensive sector while the service and agriculture sectors are human intensive sectors. Based on this, one can conclude that development or modernization of the agricultural and the service sectors will result in a great savings in labor requirements. The introduction of new and advanced technology into those two sectors means an increase in their productivity, which translates into more output and less employment.

The effect of one sector on the other sectors from the employment standpoint is very clear in Table XLV. For example, in 1990, the production of one unit of the agriculture sector product for final demand will generate about 0.00059, 0.00001, 0.00368, ----, and 0.00100 employment in the oil, mining, manufacturing, ----, and service sectors respectively. From this one can conclude that the increase in the output of the agricultural sector will affect the employment in the trade sector the most. This means there is a strong relationship between those two sectors. On the other side, the relationship between the agriculture and the mining sectors is very low. The above analysis is that of the first column in Table XLV and the rest of the column could be analyzed in the same way. Analyzing the table row wise one can see that, oil, mining, ----, and service sectors will generate 0.00045, 0.00090, ----, and 0.00045 employment in the agricultural sector. It is expected that the transport sector will generate the highest employment (0.01597) in the agricultural sector. The rest of the rows can

be analyzed in the same way.

Table XLVI gives a summary of the employment affects of the backward and forward linkage in 1985 under the first set of productivity estimates. The oil sector ranks first with respect to the backward linkage, 2.23879. This was expected because of the importance of oil in this country's economy. The agricultural and service sectors are ranked 9 and 10 respectively. What the ranking indicates is that the higher the sector in the ranking list, the more it generates employment in the rest of the sector. For example, for each 1000 workers directly employed in the oil sector, about 2239 workers are employed in the supporting sectors. On the other hand, for each 1000 workers directly employed in the agricultural sector, only 2 workers are employed in the supporting sectors. The agricultural and service sectors are also ranked 9 and 10 with respect to the forward linkage, while the finance sectors ranked first. This means that the number of workers employed in each sector to supply the rest of the sector with goods and services, per 1000 workers directly employed, would be 395 workers employed in the finance sector, 329 in the trade sector, ---, and only 1 in the agricultural sector.

The analysis of the number of workers employed in each sector by occupation per unit of output is important in determining what sectors required more of which occupations. Table XLVII shows those relationships between the sectors and the occupations. The employment in each sector of all the occupations per unit of output declines during the period from 1985 to 1990. This is a good sign for the same reason mentioned earlier. For example, in 1985, the agricultural sector requires about 1.04226, 0.27798,---and 5.04582 workers with the skill of professional, administrative ---, and production respectively to produce

TABLE XLVI

THE EMPLOYMENT EFFECTS OF THE BACKWARD AND FORWARD LINKAGE UNDER THE FIRST SET OF PRODUCTIVITY IN 1985

	Backward Linkage					Forward Linkage			
	Total	Direct	Indirect	IN/D	Rank	Total	Indirect	IN/D	Rank
Agriculture	22.55863	22.52237	0.03628	0.00161	10	22.54509	0.02272	0.00101	10
Oil	0.42765	0.13204	0.29561	2.23879	1	0.14716	0.01512	0.11451	6
Mining	1.35187	0.69704	0.65483	0.93944	2	0.73816	0.04112	0.05899	7
Manufacturing	3.34178	2.78958	0.55520	0.19924	4	3.21240	0.42282	0.15157	5
Utility	6.58397	5.60994	0.97403	0.17363	5	5.82262	0.21268	0.03791	8
Construction	2.57481	2.14214	0.43267	0.20198	3	2.53554	0.39340	0.18365	4
Trade	3.56944	3.33019	0.23925	0.07184	8	4.42573	1.09554	0.32897	2
Transport	4.11636	3.52712	0.58924	0.16706	6	4.56167	1.03455	0.29331	3
Finance	0.64160	0.56642	0.07518	0.13273	7	0.78988	0.22346	0.39451	1
Service	26.44232	26.12094	0.32138	0.01230	9	26.83821	0.71727	0.02746	9

TABLE XLVII

EMPLOYMENT BY OCCUPATION IN EACH SECTOR PER ONE MSR UNDER THE FIRST OF PRODUCTIVITY IN 1985 AND 1990

Sector	Year	Profes-sional and Technical	Adminis-trative and Managerial	Clerical	Sales	Services	Agri-culture	Production
Agriculture	1985	1.04226	0.27798	1.16378	1.23322	0.59046	13.19181	5.04582
	1990	0.82794	0.22082	0.92447	0.97963	0.46904	10.47914	4.00823
Oil	1985	0.02016	0.00323	0.00442	0.02134	0.00883	0.00	0.08918
	1990	0.01749	0.00281	0.00383	0.01851	0.00766	0.000	0.00737
Mining	1985	0.04877	0.01666	0.06422	0.00444	0.01011	0.09623	0.49774
	1990	0.03598	0.01229	0.04738	0.00327	0.00746	0.07099	0.36722
Manufacturing	1985	0.11957	0.08497	0.12332	0.16171	0.07790	0.00283	2.64207
	1990	0.09059	0.06437	0.09343	0.12252	0.05902	0.00214	2.00168
Utility	1985	0.74070	0.04804	1.10641	0.04338	0.34342	0.00786	3.53282
	1990	0.49350	0.03201	0.73717	0.02890	0.22881	0.00524	2.35381
Construction	1985	0.17759	0.05160	0.12982	0.01907	0.12470	0.00451	2.02823
	1990	0.13103	0.03807	0.09578	0.01407	0.09200	0.00333	1,49645
Trade	1985	0.18119	0.09276	0.32821	2.35971	0.73657	0.02014	0.70714
	1990	0.13800	0.07065	0.24998	1.79725	0.56101	0.01534	0.53859
Transport	1985	0.39910	0.15387	0.61352	0.07544	0.37584	0.01296	2.92791
	1990	0.31537	0.12158	0.48875	0.05803	0.29699	0.01024	2.31364
Finance	1985	0.14492	0.06434	0.31814	0.10611	0.06210	0.00720	0.08714
	1990	0.10979	0.04874	0.24103	0.08039	0.04698	0.00545	0.06602
Service	1985	5.37569	0.52791	1.43316	1.47852	7.66902	0.17874	10.17517
	1990	4.13776	0.40634	1.10313	1.13804	5.90298	0.13758	7.83200

one unit of output. This indicates that the majority of the workers in this sector have agricultural skills. The oil sector, on the other hand, requires no workers with agricultural skills. It requires mainly workers with production skill and those who are professional and technical. The rest of the figures in Table XLVII can be analyzed in the same way.

Table XLVIII shows the required number of workers in each sector for each educational level per unit of ouptput. This table demonstrates the relationship between each sector and the different levels of education, and the type of workers required by each sector. For example in 1985, the agricultural sector requires about 0.05208, 1.47648, ----, and 13.40035 workers with advanced study, university degree, ----and illiterate respectively. This indicates that the majority of the workers in the agricultural sector are illiterate. This is one of the reasons for the low productivity of this sector and the large number of workers it employs. The rest of the figures in Table XLVIII can be analyzed in the same way.

The preceding paragraphs analyzed the manpower requirements under the first set of productivity estimates. Data needed for the analysis of the manpower requirements under the second set of productivity are shown in Appendix C, Tables LXI to LXIV. Those tables can be analyzed in the same way as the tables constructed under the first set of productivity.

The determination of whether or not the expected increase in the Saudi labor force can meet the projected required manpower is very important for the process of Saudization of the labor force and of national planning. Table XLIX gives a summary comparison of the required number of workers to be imported by occupation in all scenarios under the first set of productivity. Scenario A required the least additional foreign workers to be imported (350,401) while Scenario D required the most

TABLE XLVIII

EMPLOYMENT BY EDUCATION IN EACH SECTOR PER ONE MSR UNDER THE FIRST SET OF PRODUCTIVITY IN 1985 AND 1990

Sector	Year	Advanced Study	University Degree	Same University	Technical High School	General High School	Intermediate School	Primary School	Read and Write	Illiterate
Agriculture	1985	0.05208	1.47648	0.11295	1.06819	0.52102	0.64276	0.50366	4.76783	13.40035
	1990	0.04137	1.1728	0.08972	0.84853	0.41388	0.51059	0.40009	3.78741	10.64480
Oil	1985	0.00093	0.02125	0.01067	0.01935	0.02103	0.02262	0.01549	0.03143	0.00446
	1990	0.00081	0.01843	0.00926	0.01678	0.01824	0.01962	0.01344	0.02727	0.00387
Mining	1985	0.00314	0.05914	0.04225	0.12693	0.04148	0.10409	0.15166	0.15735	0.05214
	1990	0.00231	0.04363	0.03117	0.09364	0.03061	0.07679	0.11189	0.11609	0.03847
Manufacturin	1985	0.00646	0.09252	0.06380	0.08481	0.12416	0.17202	0.21488	1.33964	1.11416
	1990	0.00489	0.07009	0.04833	0.06425	0.09407	0.13033	0.16280	1.01493	0.84411
Utility	1985	0.02230	0.49411	0.19011	0.40106	0.57854	0.47705	0.84760	1.37909	1.43277
	1990	0.01486	0.32921	0.12666	0.26722	0.38546	0.31784	0.56473	0.91884	0.95461
Construction	1985	0.00783	0.13694	0.05342	0.10304	0.22445	0.21433	0.24899	0.99419	0.55232
	1990	0.00578	0.10104	0.03942	0.07603	0.16560	0.15813	0.18371	0.73352	0.40750
Trade	1985	0.00983	0.16464	0.10480	0.07568	0.26094	0.35087	0.39252	1.89638	1.17007
	1990	0.00748	0.12539	0.07982	0.05764	0.19874	0.26724	0.29896	1.44436	0.89118
Transport	1985	0.03412	0.37483	0.13936	0.20879	0.72261	0.41844	0.40385	1.35559	0.90408
	1990	0.02696	0.29619	0.11012	0.16498	0.57101	0.33065	0.31912	1.07119	0.71440
Finance	1985	0.01287	0.15567	0.04084	0.02581	0.14418	0.08160	0.07297	0.18096	0.07497
	1990	0.00975	0.11794	0.03094	0.01956	0.10924	0.06182	0.05528	0.13710	0.05680
Service	1985	0.42539	1.88941	1.02763	1.10761	1.53246	3.03916	3.29520	7.71035	6.81318
	1990	0.32743	1.45431	0.79099	0.85255	1.17956	2.33929	2.53637	5.93479	5.24420

TABLE XLIX

THE DIFFERENCES BETWEEN THE REQUIRED AND AVAILABLE SAUDI LABOR IN 1990
UNDER THE FIRST SET OF PRODUCTIVITY
(IN THOUSANDS)

	A			B			C			D		
Occupation	Required	Available	Difference	Required	Available	Difference	Required	Available	Difference	Required	Available	Difference
Professional and Technical	229.545	190.674	38.871	317.134	171.201	145.933	247.543	199.179	48.364	342.863	183.912	158.951
Administrative and Managerial	52.002	43.196	8.806	72.501	39.139	33.362	55.0922	44.3282	10.764	76.466	41.251	35.215
Clerical and Related Workers	140.466	116.679	23.787	212.230	114.570	97.660	149.464	120.262	29.202	222.713	120.316	102.397
Sales Workers	198.452	164.846	33.606	327.025	176.541	150.484	201.439	162.083	39.356	321.609	171.880	149.729
Service Workers	215.736	179.203	36.533	323.150	174.449	148.701	240.250	193.311	46.939	359.017	192.506	166.511
Agriculture Workers	479.033	397.913	81.120	763.195	412.003	351.192	418.152	336.455	81.697	623.666	333.448	290.218
Production and Related Workers	752.911	625.412	117.499	2267.624	630.329	537.295	823.152	662.327	160.825	1260.988	675.490	585.498
Total	2069.204	1718.803	350.401	3183.917	1718.803	1465.114	2136.158	1718.803	417.355	3208.383	1718.803	1489.580

TABLE L

THE DIFFERENCES BETWEEN THE REQUIRED AND AVAILABLE SAUDI LABOR IN 1990
UNDER THE SECOND SET OF PRODUCTIVITY
(IN THOUSANDS)

	A			B			C			D		
Occupation	Required	Available	Difference	Required	Available	Difference	Required	Available	Difference	Required	Available	Difference
Professional and Technical	267.853	219.254	48.599	366.027	198.202	167.825	292.648	226.707	65.941	403.405	210.210	193.195
Administrative and Managerial	54.341	44.482	9.859	75.117	40.675	34.442	58.174	45.066	13.108	80.478	41.936	38.542
Clerical and Related Workers	143.113	117.145	25.968	213.838	115.792	98.046	154.456	119.653	34.803	228.704	119.175	109.529
Sales Workers	185.135	151.545	33.590	303.839	164.527	139.31	191.390	148.265	43.125	305.497	159.191	146.306
Service Workers	268.257	219.254	48.672	391.688	212.097	179.591	300.898	233.099	67.799	441.077	229.840	211.237
Agriculture Workers	353.588	289.434	64.154	561.594	304.100	257.494	309.732	239.942	69.790	460.770	240.108	220.662
Production and Related Workers	826.435	676.489	149.946	1262.079	683.409	578.670	910.380	705.250	205.130	1378.550	718.348	660.202
Total	2099.782	1718.803	380.979	3174.182	1718.803	1455.378	2217.678	1718.803	499.596	3298.481	1718.803	1579.673

1,489,589. The main reason for this difference in the required additional foreign workers is that Scenario D expected the favorable condition of the mid-70's, after 1973, to repeat itself during the 1980's. On the other hand, Scenario A expected very moderate changes in the independent variables. The other two Scenarios, B and C fall in between with the latter closer to Scenario A and the former closer to Scenario D.

By 1990, Scenario A expects the foreign workers to account for 45.1 percent of the total work force compared to 59.6, 46.2, and 59.7 percent by the other Scenarios B, C, and D respectively. This indicates that even under the very tight conditions, Saudi Arabia continues to rely on foreign workers in all types of occupations. The main reason for its reliance on foreign workers is the inability of its population to produce enough men to join the worker force. The reliance on foreign workers can be cut drastically if women's participation in the labor force increases.

Table L gives a summary comparison of the required number of workers to be imported by occupation in all scenarios under the second set of productivity. This table is very similar to the previous table, Table XLIX, and can be analyzed in the same way. All the scenarios in Table L give a higher estimate for the additional labor to be imported than those in table XLIX, with the exception of Scenario B.

CHAPTER VIII

SUMMARY, FINDINGS, CONCLUSIONS AND LIMITATIONS

8.1 Summary

Saudi Arabia has faced, and still faces, a complex set of social, cultural, and institutional relationships that impede the optimal utilization of its resources in general and its human resources in particular. This study started [Chapter II] by pointing out some of the factors affecting the growth and the utilization of the human resources of the country. Some of these factors are: the low literacy level among the population, the high mortality rate due to poor health care, low participation by women in the labor force, and the negative attitude toward manual and technical work.

In Chapter III, the difference between national and partial planning and the country's experiences with national planning were discussed and analyzed. The history of planning in Saudi Arabia prior to the introduction of the first development plan was reviewed. The different committees and organizations which were in charge of planning prior to the formation of the CPO were presented in this chapter. The objectives of the previous plans were discussed, evaluated, and the degrees to which they had been accomplished were measured. This chapter ended with an outlook into the expected goals of the fourth development plan, 1985 - 1990.

The main approaches to manpower planning were discussed in Chapter IV. The manpower-forecasting approach was selected for use in this study. The main reasons for choosing this approach over that of the rate of return is that the latter is more appropriate for a country with limited revenue, while the former provides the educational planners with a tool by which they can tailor the expansion of the educational system in order to meet the required educated manpower. Input-output was the technique adopted in this study under the manpower-forecasting approach. A survey of literatures related to input-output was presented in Chapter IV. The visibility of applying this technique to a developing country like Saudi Arabia was examined in this chapter.

The interindustry and human resource accounts were presented in Chapter V. The development of the interindustry account was accomplished in the form of three tables: (1) the transaction or interindustry flow table, (2) the direct coefficients table, and (3) the direct and indirect coefficient table. The second table is derived from the first table and the third table is derived from the second. It is actually a chain of tables, with the development of the last table depending on the development of the one immediately preceding it. Each element in the transaction table represents the amount purchased by the column sector and sold by the row sector. The direct coefficients table does not record the value of each transaction like the transaction table, but it records the amount purchased per unit of output of the purchasing sector. It actually reveals the direct dependency of each sector on all other sectors in the account.

The human resource account was developed around several matrices and vectors. These matrices are: (1) occupational labor coefficient

matrix, (2) sector by occupation matrix, (3) educational labor coefficients matrix, and (4) sector by education matrix. The vectors required for the development of this account are: (1) total employment by sector vector, (2) total employment by occupation vector, (3) total employment by education, and (4) sectoral labor productivity. Occupational and educational labor coefficient matrices show the change in labor requirements in each occupational and educational level as a result of one unit change in total column occupation and education.

In Chapter VI, a brief survey of the forecasting techniques was conducted to set up the base for the development of the final demand model. Final demand consists of four exogenous sectors: private and government consumption, gross capital formation, and exports. A causal forecasting model was developed for each exogenous sector in order to project its future value. The statistical accuracy as well as the economical validity of the model was examined and proved satisfactory. The model was used to project the future value of each final demand sector. Three statistical criteria were used to check the accuracy of the model: the standard deviation of the residual, S, the goodness of fit, R^2, and the F-test.

The choice of the independent variables in the final demand model depended on the theoretical desirability of those variables and the availability of historical data. An estimation of the future value of those variables was needed in order to forecast the future value of the dependent variables. Four sets of estimations of the independent variables from 1981 to 1990 were made. Each set represented a scenario. The first estimation represents the MOP and the OPEC expectation of the future growth rate of the independent variables in the model. The

second estimation represents other economists' view of the expected future growth of those variables. The first and second estimations are called the insider and outsider scenarios, or Scenarios A and B. The third estimation, Scenario C, expected the growth rate of the independent variables to follow that achieved prior to 1973, while the fourth estimation, Scenario D, expected the current 1973-1980 growth rate of those independent variables to continue throughout the 1980's.

In Chapter VII, the manpower requirement model was constructed around the open input-output model. The model was developed in a recursive sequence of equations. It consists mainly of 41 major equations. The majority of those equations was disaggregated into sub-equations. Most of those equations consist of 10 sub-equations, one for each endogenous sector. Aggregate final demand components were determined outside this model and were used as inputs to the model. The accuracy of this model in projecting sectoral manpower requirements was examined by the chi-square goodness of fit technique. OMNITAB and SAS languages were used to solve the system of equations making up the manpower requirements model. Economic as well as educational planners can use this model as an experiemental tool to examine the impact of different development strategies on the supply and demand of human resources.

8.2 Findings and Conclusions

The conclusions of this study are based on the outcome of three analyses: (1) the analysis of the factors affecting the growth and utilization of manpower, and the participation of the population in the labor force; (2) the analysis of the previous development plans; and (3)

the analysis of the outcome of the implementation of the model. The first and second analysis revealed the following findings:

1. A complex set of cultural, social, and institutional relationships exist in Saudi Arabia and played and continue to play a major role in the utilization of the human resources and the participation of the population in the labor force.

2. Women's participation in the labor force is very low because of the limited avenues open to them. It is fair to say that women's participation in labor forces in Saudi Arabia is one of the lowest, if not the lowest, in the world.

3. The literacy rate is very low and the educational system is biased in favor of more traditional types of education.

4. The infant mortality rate is high due to poor health care (about 150 deaths per 1,000 in 1980).

5. The size of the middle class in the country is increasing with the rapid transformation of the country from a traditional economy based on agriculture and herding to a modern economy based on the exploitation of oil and the expanding role of the government.

6. The oil sector continues to dominate the economy, and the country's income depends to a large extent on the production and price of this nonrenewable resource.

7. The private sectors played very limited roles in the development of the country, while the government sector is considered the major fueler of the development process in the country.

8. During the past decade, few changes have occurred in the structure of the economy.

The analysis of the results obtained from the implementation of the

model revealed the following conclusions:

1. Scenarios A and C estimate a low increase in the demand for labor during the 1980's, while Scenarios B and D estimate a very high increase in the demand for labor during the same period.

2. Total demand for labor will increase by at least 26.6 percent, and at most by 76.4 percent during the third and fourth development plans.

3. The private sector employment is expected to increase by at least 19.8 percent and at most by 77.0 percent, while the government sector employments is expected to increase by 72.4 percent during the 1980's.

4. All the scenarios under the first set of productivity projected a lower total labor demand than those projected under the second set of productivity, except with regard to Scenario B where the opposite occurred.

5. The required demand for labor in all occupations estimated by the four scenarios under the two sets of productivity is expected to increase during the 1980's, with the exception of the agricultural and production occupations.

6. The required demand for labor with all levels of education estimated by the four scenarios under the two sets of productivity is expected to increase during the 1980's except for those who know how to read and write and those who are illiterate.

7. The oil sector ranked first with respect to the ability of an individual sector to generate employment in the rest of the sectors, while the service and agricultural sectors ranked 9 and 10.

8. The oil sector is very advanced technologically and it is a

capital intensive sector, while the service and agricultural sectors are primative and are human intensive sectors.

9. The estimated increase in the domestic labor force will fall short of meeting the required increase in the demand for labor in all occupations.

Based on the above findings, this study concludes that Saudi Arabia will continue to face shortages in manpower and will continue to rely on foreign workers for the achievement of its developmental objectives during the period under study and beyond. The attempts by the MOP to place a ceiling of 9,000 additional foreign workers imported into the country during the third development plan (1980-1985) is a highly optimistic goal and is very hard to achieve based on the above findings and the achievement of the first two years of the third development plan [92]. Several reasons are attributed to the reliance on foreign workers: (1) the low participation rate of the population in general and women in particular in the labor force, (2) the low increase in the domestic labor force, and (3) the attitude of Saudis toward work in general and manual labor in particular. The reliance on foreign workers will cause severe problems, socially and economically. Economically, it will discourage citizens from joining the labor force, especially those who are considered part-time workers or secondary earners. Socially, new values and morals will be brought into the country which could be in conflict with the present values and morals of the country. To reduce reliance on foreign workers by changing the attitude of Saudis toward work and increase their participation in the labor force may take a whole generation to achieve.

A point of caution is due here. Medium and long range forecasts

must not be taken totally for granted because of the uncertainty associated with these kinds of forecasting procedures. Future estimates of the economic growth of the country over long periods are uncertain. Because of these different estimations, or different scenarios of the economic growth in the country were considered in this research.

8.3 Limitations

There are two major sources of limitations in this study, namely, data limitations and model assumptions. Actually, the latter source of limitations came as a result of the former source of limitations.

A study of this magnitude requires a vast amount of data which, in most cases, is not available. Time and funds prohibit the collection of primary data to fill in the gaps, and the researcher has to "make do" with what is available in the expanse of less detailed and maybe accurate results. For example, the economic activities in this study were divided into 10 endogenous sectors and manpower needs were divided into seven groups of occupations and nine educational levels. Those levels of aggregation were imposed because of the inavailability of more detailed data. Productivity in this study was measured as sector GDP per sector employee instead of sector output per sector employee. Again, lack of data concerning sector output was the main reason for using sector GDP instead of sector output.

The second source of limitations, model assumptions, is the result of building this model around the input-output technique. This means that the manpower requirement model will be subjected to the assumptions of the input-output model. The most rigid and restrictive assumption is the constant technical coefficients. This assumption

means that, regardless of the year, the level of output in any given sector requires a specific amount of input from the other sectors per unit of output, and that those requirements will be fixed throughout the period under study. This assumption is not unrealistic for a country like Saudi Arabia where the structure of its economy has experienced little change over the past decade. The other rigid assumption made is that the proportionality distribution of the final demand component in the base year, elements in the final demand coefficients matrix, will hold throughout the period under study. The main reason behind this assumption is lack of data. This assumption is also not unrealistic for a developing country like Saudi Arabia because of the nature and characteristics of the economy of Saudi Arabia and the use of the domestic inverse instead of the total inverse.

BIBLIOGRAPHY

1. AL-Ali, H. M. and Yahya, M. Jammal. Private Consumption Pattern in the Saudi Arabian Economy. Riyadh: MOP, 1982.

2. AL-Bashir, Faisal. S. Saudi Arabian Economy: 1960-1970. New York: John Wiley and Sons, Inc., 1977.

3. AlGHOFaily, I. F. "Saudi Youth Attitudes Toward Work and Vocational Education: A Constraint on Economic Development." (Unpublished Ph.D. dissertation, Florida State University, 1980.)

4. AL-Madani, Abdel R. and Muhamed AL-Fayez. Population Bulletin-of the United Nations Commission for Western Asia. No. 10 and 11, 1976, p. 186.

5. Almon, Clopper, Margare Buckler, Lawrence C. Horwicz, and Thomas C. Reinbold. 1985: Interindustry Forecasts of the American Economy. Lexington: Lexington Books, D. C. Health and Company, 1974.

6. ALyamamah. No. 746, April 6-12, 1983, pp. 3-13.

7. ALyamamah. No. 747, April 13-19, 1983, pp. 3-12.

8. ALyamamah. No. 749, April 27, 1983, pp. 3-15.

9. Anderson, C. A. and M. J. Bowman. "Theoretical Consideration in Educational Planning." Economics of Education. Edited by M. Blaug. London: Penguin Books Ltd., 1971, pp. 372-374.

10. AsFour, E. Y. Saudi Arabia: Long-term Projection of Supply and Demand for Agricultural Product. Beirut: American University, 1965, p. 142.

11. Assaf, I. A. "The Economic Impact of Guest Workers in Saudi Arabia." (Unpublished Ph.D. dissertation, Colorado State University, 1982.)

12. Arabia, The Islamic World Review. No. 23, July 1983, pp. 39-55.

13. Bahry, Louay. "New Saudi Women: Modernizing in an Islamic Framework." Middle East Journal, Vol. 36, No. 4 (1982), pp. 502-515.

14. Ballol, Mukhtar, M. "Economic Analysis of The Long-term Planning Invest-ment Strategies for The Oil Surplus Funds in Saudi Arabia." (Unpublished Ph.D. dissertation, University of Houston, 1981.)

15. Barker, T. S. "Projecting Alternative Structures of the British Economy." Advances in Input-Output Analysis. Edited by K. R. Polenske and J. V. Skolka. Cambridge, MA: Ballinger Publishing Co., 1976, pp. 3-24.

16. Barna, Tibor, Ed. The Structural Interdependence of the Economy. Proceedings of an international conference on input-output analysis, Varenna, 27 June-10 July 1954. New York and Milano, 1956.

17. Barna, Tibor, Ed. Structural Interdependence and Economic Development. Proceedings of an international conference on input-output techniques, Geneva, September 1961. New York: St. Martin's Press, 1963.

18. Bendard, J. "Intersected Optimization and Development of the Educational System." Contribution to Input-Output Analysis. Edited by A. P. Carter and A. Brody. Amsterdam: North-Holland Publishing Co., 1970, pp. 320-343.

19. Berman, E. B. The 1955 and 1975 Interindustry Final Bills of Goods and Generated Activity Levels. U.S. Bureau of Mines: Interindustry Item No. 16, 1953.

20. Birks, J. S. and C. A. Sinclair. Arab Manpower: The Crisis of Development. New York: St. Martin's Press, 1980.

21. Blaug, Mark. A Cost-Benefit Approach to Educational Planning in Developing Countries. International Bank for Reconstruction and Development, International Development Association, Economics Department, No. EC-157, December 1967.

22. Bodkin, Ronald G. "A Large-Scale Input-Output Econometric Model of the Canadian Economy (CANDIDE)." Advances in Input-Output Analysis. Edited by K. E. Polenske and J. V. Skolka. Cambridge, MA: Ballinger Publishing Co., 1976, pp. 27-44.

23. Bowerman, B. L. and Richard T. O'Connell. Forecasting and Time-Series. MA: Duxbury Press, 1979.

24. Brody, A. and A. P. Carter, Eds. Input-Output Techniques. Amesterdam: North-Holland Publishing Company, 1972.

25. Brody, A. "Optimal and Time-Optimal Paths of the Economy." Contribution to Input-Output Analysis. Edited by A. P. Carter and A. Brody. Amsterdam: North-Holland, 1972, pp. 62-74.

26. Carter, A. P. and A. Brody, Eds. Input-Output Techniques - Vol. I. Contributions to Input-Output Analysis. Amsterdam: North-Holland Publishing Company, 1970.

27. Carter, A. P. and A. Brody, Eds. Input-Output Techniques - Vol. II. Application of Input-Output Analysis. Amsterdam: North-Holland Publishing Company. 1972.

28. Carter, Anne. "A Linear Programming System Analyzing Embodied Technological Change." Contributions to Input-Output Analysis. Amsterdam: North-Holland Publishing Company, 1970, pp. 77-98.

29. Central Department of Statistic (CDS). Statistical Yearbook 1967. Vol. 3. Riyadh: 1967.

30. Central Department of Statistic (CDS). Statistical Yearbook 1971. Vol. 11. Riyadh: 1975.

31. Central Department of Statistic (CDS). Statistical Yearbook 1981. Vol. 17. Riyadh: 1981.

32. Chenery, H. B. and T. Watanable. "International Comparisons of the Structure of Production." Econometrica, Vol. 24 (October 1958), pp. 487-521.

33. Chenery, H. B. and P. G. Clark. Inter-industry Economics. New York: John Wiley, Inc., 1959.

34. Chenery, H. B. "Interindustry Analysis in Development Programming." Structural Interdependence and Economic Development. New York: St. Martin's Press, (1963).

35. Chenery, H. B. and P. G. Clark. Inter-industry Economics. New York: John Wiley, Inc., 1967.

36. Chipman, J. S. "The Multi-Sector Multiplier." Econometrica, Vol. 18 (October 1950), pp. 355-374.

37. Christ, C. F. "A Review of Input-Output Analysis." Studies in Income and Wealth. Vol. 18. Princeton University Press for National Bureau of Economic Research, 1954, pp. 139-141.

38. Clark, P. G. "The Telephone Industry: A Study in Private Investment." The Studies in the Structure of the American Economy. Edited by W. Leontief. New York: Oxford University Press, 1953, Second Print, 1965.

39. Clark, P. B. and L. Taylor. "Dynamic Input-Output Planning with Optimal End Conditions: The Case of Chile." Economic of Planning, Vol. 11 (1971), pp. 10-30.

40. Cleren, Jean Paul. Saudi Arabia 2000. London: Croom Helm, LTD, 1978.

41. Crane, R. D. Planning The Future of Saudi Arabia. New York: Praeger Publishers, Inc., 1978.

42. Cumberland, J. H. and Bruce N. Stram. "Empirical Application of Input-Output Models to Environmental Problems." Advances in Input-Output Analysis. Edited by K. R. Polenske and J. V. Skolka. Cambridge, MA: Ballinger Publishing Company, 1976, pp. 365-382.

43. Dantzig, G. B. "Optimal Solution of a Dynamic Leontief Model with Substitution." Econometrica, Vol 23 (July 1955), pp. 295-302.

44. Dorfman, R. "The Nature and Significance of Input-Output." Review of Economic and Statistics, Vol. 36 (May 1954), pp. 121-133.

45. Dorfman, R., P. A. Samuckson, and R. M. Solow. Linear Programming and Economic Analysis. New York: McGraw-Hill Co., 1958.

46. Edens, D. G. and W. P. Snovely. "Planning for Economic Development in Saudi Arabia." The Middle East Journal, Vol. 24, No. 1 (Winter 1970), p. 22.

47. Eleish, G. E. "The Input-Output Model in a Developing Economy: Egypt." Structural Interdependence and Economic Development. New York: St. Martin's Press, 1963, pp. 199-220.

48. EL Mallakh, Ragace. Saudi Arabia Rush to Development. Baltimore: Johns Hopkins University Press, 1982

49. Evans, W. D. and M. Hoffenberg. "The Interindustry Relations Study for 1947." The Review of Economics and Statistics, Vol. 34 (May 1952), pp. 97-142.

50. FEI, Ching-Han. "A Fundamental Theorem for the Aggregation Problem of Input-Output Analysis." Econometrica, Vol. 24 (October 1958), pp. 400-412.

51. Flick, Warren A. "Environmental Repercussions and the Economic Structure: An Input-Output Approach: Comment." (Leontief) The Review of Economics and Statistics, Vol. 57 (February 1974), pp. 107-109.

52. Gale, D. The Theory of Linear Economic Models. New York: McGraw-Hill Co., 1960.

53. Ghosh, A. New Horizons in Planning. Calcutta: The World Press Private Ltd., 1956.

54. Ghosh, A. Programming and Interregional Input-Output Analysis. Cambridge: The University Printing House, 1973.

55. Godet, Michel. The Crisis in Forecasting and the Emergence of the "Prospective" Approach. New York: Pergamon Press, 1979.

56. Goodwin, R. M. "The Multiplier as Matrix." Economic Journal, Vol. 59 (December 1949), pp. 537-555.

57. Hadley, G. Linear Programming. London: Addison-Wesley Publishing Co., Inc., 1963.

58. Haig, B. D. and M. P. Wood. "A Dynamic Model for Analyzing Price Changes." Advances in Input-Output Analysis. Edited by K. R. Polenske and J. V. Skolka. Cambridge, MA: Ballinger Publishing Company, (1976), pp. 73-91.

59. Hartog, H. D. and A. Houweling. "Pollution, Pollution Abatement, and the Economic Structure of the Netherlands." Advances in Input-Output Analysis. Edited by K. R. Polenske and J. V. Skolka. Cambridge, MA: Ballinger Publishing Co., 1976, pp. 389-408.

60. Hawkins. "Some Conditions of Macroeconomic Stability." Econometrica, Vol. 16 (October 1948), pp. 309-322.

61. Holley, J. L. "A Dynamic Model--Part I." Econometrica, Vol. 20 (October 1952), pp. 616-642.

62. Holley, J. L. "A Dynmamic Model--Part II." Econometrica, Vol. 21 (April 1953), pp. 298-324.

63. International Bank for Reconstruction and Development. Human Resource Development in the Kingdom of Saudi Arabia. Vol. 1. Washington, D.C., December 1974.

64. International Bank for Reconstruction and Development. Human Resource Development in Kingdom of Saudi Arabia. Vol. 3. Washington, D. C., December 1974.

65. Ivanov, I. N. "A Dynamic Optimal Path of Economic Growth." Advances in Input-Output Analysis. Edited by K. R. Polenske and J. V. Skolka. Cambridge, MA: Ballinger, 1976, pp. 563-568.

66. Kementa, J. Elements of Econometrics. New York: The MacMillan Co., 1971.

67. Key, Shirly. "Social Change in Modern Saudi Arabia." State, Society and Economy in Saudi Arabia. Edited by Tim Niblock. New York: St. Martin's Press, 1982.

68. Knquerbase, R. "Saudi Arabia's Economy at the Beginning of the 1970s." The Middle East Journal, Vol. (Spring 1974), pp. 126-140.

69. Knauerhase, R. The Saudi Arabian Economy. New York: Proeger Publishers, 1975.

70. Johansen, L. A Multisectoral Study of Economic Growth. Amsterdam: North-Holland Publishing Co., 1964.

71. Jones, Aubrey. Oil: The Missing Opportunity or Naft and Shaft. New York: Universe Press, 1981.

72. Lumas, P. S. "Key Sectors in Some Underdeveloped Countries." Kyklos, Vol. 28 (1975), pp. 62-79.

73. Lebkicker, Roy, George Renz, and Max Steineke. Aramco Handbook. Dahran: 1960.

74. Leontief, W. "Quantitative Input-Output Relations in the Economic System of the United States." The Review of Economics and Statistics, Vol 18 (August 1936), pp. 105-125.

75. Leontief, W. W. The Structure of American Economy. 1910-1939. Second Edition. New York: Oxford University Press, 1951.

76. Leontief, W. Studies in the Structure of the American Economy: Theoretical and Empirical Explorations in Input-Output Analysis. New York: Oxford University Press, 1953, Second Print, 1964.

77. Leontief, W. Input-Output Economics. New York: Oxford University Press, 1966.

78. Leontief, W. "Environmental Repercussions and the Economic Structure: An Input-Output Approach." The Review of Economics and Statistics, Vol. 52 (August 1970), pp. 262-271.

79. Leontief, W. and D. Ford. "Air Pollution and the Economic Structure: Empirical Results of Input-Output Computations." Input-Output Techniques. Edited by A. Brody and A. P. Carter. Amsterdam: North-Holland Publishing Company, 1972, pp. 9-30.

80. Long, N. B. "An Input-Output Comparison of the Economic Structure of the U.S. and the U.S.S.R." The Review of Economics and Statistics, Vol. 52 (November 1970), pp. 434-441.

81. Makridakis, S. and Steven C. Wheelwright. Forecasting: Methods and Applications. New York: John Wiley and Sons, 1978.

82. Miernyh, W. H. The Elements of Input-Output Analysis. New York: Random House, 1965.

83. Ministry of Education. Educational Statistics in the Kingdom of Saudi Arabia, 1979-1980. Riyaelh: Al-Nasr Al-Hadithah Press, 1981.

84. Ministry of Finance and National Economy. Survey of Population, Buildings, and Establishment, 1962. Riyadh: Island Press, 1963.

85. Ministry of Finance and National Economy. Statistical Yearbook, 1967. Riyadh: National Offset Press, 1967.

86. Ministry of Finance and National Economy. Statistical Yearbook, 1968. Dammam: Al Mutawwa Press, 1968.

87. Ministry of Higher Education. Statistical Index on Progress of Higher Education From 1969/70 to 1979/80. Riyadh: March 1982.

88. Ministry of Labor and Social Affairs. Statistical Publication about Workers, Occupations, Wages, and Working Hours in the Private Sector in the Kingdom During 1979-1980. Riyadh: 1981.

89. Ministry of Planning (MOP). Economic Report. Riyadh: 1965.

90. Ministry of Planning (MOP). First Development Plan 1970-1975. Riyadh: 1970.

91. Ministry of Planning (MOP). Second Development Plan 1975-1980. Riyadh: 1975.

92. Ministry of Planning (MOP). Third Development Plan 1980-1985. Riyadh: 1980.

93. Ministry of Planning (MOP). Achievement of the First and Second Development Plans (1970-1980). Riyadh: 1982.

94. Mishan, E. J. Cost-Benefit Analysis. New York: Praeger Publishers, Inc., 1971.

95. Montgomery, D. C. and L. A. Johnson. Forecasting and Time Series Analysis. New York: McGraw-Hill Book Co., 1976.

96. Murakami, Y., Tokoyama and J. Tsukui. "Efficient Paths of Accumulation and the Turnpike of the Japanese Economy." Application of Input-Output Analysis. Edited by A. P. Carter and A. Brody. Amsterdam: North-Holland Publishing Co., 1972, pp. 24-47.

97. Mycielski, J., K. Rey and W. Trzeciakowski. "Decomposition and Optimization of Short-Run Planning in a Planned Economy." Structural Interdependence and Economic Development. Edited by T. Barna. New York: St. Martin's Press, 1963.

98. Myrdal, G. Beyond the Welfare State. New Haven: Yale University Press, 1964, p. 20.

99. Nyrop, R. F., Benderly, B. L., Carter, L. N., Eglin, D. R., and R. A. Kirchner. Area Hanbook for Saudi Arabia. Washington, D. C.: Government Printing Office, 1977.

100. OECD. "Critical Assessment of the First Stage of the MRP." Planning Education for Economic and Social Development. Edited by H. S. Parnes. Paris: 1964.

101. Organization of the Petroleum Exporting Countries (OPE). Annual Statistical Bulletin 1980. Vienna: 1980.

102. Organization of the Petroleum Exporting Countries (OPE). Fact and Figures: A Comparative Statistical Analysis. Vienna: 1981.

103. Ozaki, I. "The Effect of Technological Changes on the Economic Growth of Japan, 1955-1970." Advances in Input-Output Analysis. Edited by K. R. Polenske and J. V. Skolka. Cambridge, MA: Ballinger Publishing Co., 1976, pp. 93-111.

104. Parnes, H. S. Forecasting Educational Needs for Economic and Social Development. Paris: OECD, 1962.

105. Parssinen, Catherine. "The Changing Role of Women." King Faisal and Modernization of Saudi Arabia. Edited by Willard A. Beling. London: Croom Helm, Ltd., 1980, pp. 145-170.

106. Paukert, F., J. Skolka and J. Maton. "Redistribution of Income, Patterns of Consumption, and Employment: A Case Study for the Philippines." Advances in Input-Output Analysis. Edited by K. R. Polenske and J. V. Skolka. Cambridge, MA: Ballinger Publishing Company, 1976, pp. 161-168.

107. Peacock, A. T. and D. M. Dosser. "Input-Output Analysis in an Underdeveloped Country." The Review of Economic Studies, Vol. 25 (October 1957), pp. 21-24.

108. Polenske, K. R. and J. V. Skolka, Eds. Advances in Input-Output Analysis. Cambridge, MA: Ballinger Publishing Company, 1976.

109. Richardson, H. W. Input-Output and Regional Economics. New York: John Wiley and Sons, Inc., 1972.

110. Santhanam, K. W. and R. H. Patil. "A Study of the Production Structure of the Indian Economy." Econometrica, Vol. 40 (November, 1972), pp. 159-176.

111. Saudi Arabian Monetary Agency (SAMA). Annual Report 1961 to 1981. Riyadh: 1961-1981.

112. Saudi Arabian Monetary Agency (SAMA). Statistical Summary. Riyadh: 1982.

113. Sayidaty. Vol 1, No. 27. 1981.

114. Schreiner, P. "The Role of Input-Output in the Perspective Analysis of the Norwegian Economy." Input-Output Techniques. Edited by A. Brody and A. P. Carter. Amsterdam: North-Holland Publishing Co. (1972), pp. 449-475.

115. Schultz, Sigfried. "Approaches to Identifying Key Sectors Empirically by Means of Input-Output Analysis." Journal of Development Studies. Vol. 14 (October 1977), pp. 77-96.

116. Seers, D. and C. R. Ross. The Financial and Physical Problems of Development in the Gold Coast. Gold Coast, July 1952.

117. Shishido, S. "Problems in the International Standardization of Inter-industry Tables." Journal of the American Statistical Association, Vol. 59 (March 1964), pp. 256-272.

118. Shishido, S. and A. Oshizaka. "Inventory Adjustment in a Quarterly Input-Output Model for Japan." Advances in Input-Output Analysis. Edited by K. R. Polenske and J. V. Skolka. Cambridge, MA: Ballinger Publishing Company (1976), pp. 45-72.

119. Simpson, D. and J. Tsukui. "The Fundamental Structure of Input-Output Tables: An International Comparison." The Review of Economics and Statistics, Vol. 47 (November, 1965), pp. 434-446.

120. Smith, P. and W. I. Morrison. Simulating the Urban Economy: Experiments with Input-Output Techniques. London: Prio Limited, 1974.

121. Solow, R. "On the Structure of Linear Models." Econometrica, Vol. 20 (January 1952), pp. 29-46.

122. Song, B. N. "The Production Structure of the Korean Economy: International and Historical Comparisons." Econometrica, Vol. 45 (January 1977), pp. 147-162.

123. Steenge, A. E. "Environmental Repercussions and the Economic Structure: Further Comments (Leontief), (Flick)." The Review of Economics and Statistics, Vol. 60 (August 1978), pp. 482-486.

124. Stone, R. and A. Brown. "A Computable Model of Economic Growth." A Programme for Growth. Vol. 1. Edited by Richard Stone. London: Chapman and Hall, July, 1962.

125. Stone, R. "Demographic Input-Output: An Extension pf Social Accounting." Contribution to Input-Output Analysis. Edited by A. P. Carter and A. Brody. Amsterdam: North-Holland Publishing Co., 1970, pp. 293-319.

126. The Europe Yearbook, Statistical Survey. A World Survey. Vol. II. London: Europa Publications, 1975.

127. The Netherlands Economic Institute, Ed. Input-Output Relations. Proceedings of a conference in interindustrial relations held at Driebergon, Holland. Leiden, 1953.

128. Thonstad, T. and T. Kobberstad. "Educated Manpower Behind Norway's Exports, Domestic Consumption, and Investment." Review of Income and Wealth, Vol. 17 (September 1971), pp. 253-260.

129. Tinbergen, J. Central Planning. New Haven: Yale University Press, 1964.

130. Tinbergen, J. and H. Bos. Econometric Models of Education. Paris: OECD, 1965.

131. Tsukui, J. "Optimal Path in a Non-Linear Dynamic Input-Output System." Input-Output Techniques. Edited by A. Brody and A. P. Carter. Amsterdam: North-Holland, 1972, pp. 551-562.

132. Tsukui, J. and Y. Murakami. Turnpike Optimality in Input-Output Systems: Theory and Applications for Planning. Amsterdam: North-Holland Publishing Co., 1979.

133. Tweeten, L. and G. L. Brinkman. Micropolitan Development Theory and Practice of Greater - Rural Economic Development. Ames: Iowa State University Press, 1976.

134. United Nations Economic Commission for Latin America. Analysis and Projection of Economic Development. Part III. Economic Development of Columbia, 1957.

135. United Nations Economic Commission for Latin America. Analysis and Projection of Economic Development. Part IV. Economic Development of Argentina, 1958.

136. United Nations. Sectoral Output and Employment Projection. Development Programming Techniques. Series No. B, ECAFE, Bangwaw, 1970.

137. United Nations. Input-Output Tables and Analysis. Studies in Methods. Series F, No. 14, Rev. L. New York, 1973.

138. United Nations Economic Commisssion for Western Asia. Social and Economic Data Sheet. Beirut, 1978.

139. United Nations. Planning in Developing Countries Theory and Methodology. U.S.S.R: Progress Publishers, 1980.

140. United State Department of Labor. "Women Begin to Emerge from the Traditional Role." Labor Development Abroad, Vol. 15, No. 6 (1970), p. 20.

141. Vandenvell, C. A. "Input-Output Analysis as a Tool for Long-Term Projections." Paper presented to the Varenna Input-Output Conference. 1954. The paper is summarized in P. J. Verdoorn's "Complementarity and Long-Range Projection." Econometrica, Vol. 24 (October 1956), pp. 429-450.

142. Weisskoff, Richard. "Income Distribution and Export Promotion in Puerto Rico." Advances in Input-Output Analysis. Edited by K. E. Polenske and J. V. Skolka. Cambridge, MA: Ballinger Publishing Co., 1976, pp. 205-228.

143. World Bank. World Development Report 1981. Washington, D. C.: Oxford University Press, August, 1982.

144. World Health Organization. Report on a Health Survey of Saudi Arabia: November 10, 1962-January 31, 1963. United Nations, July 1963, pp. 59-66.

145. Yusif, A. Sayigh. The Economics of the Arab World. New York: St. Martines Press, 1978.

APPENDIXES

APPENDIX A

CLASSIFICATION OF INDUSTRIES AND OCCUPATIONS, DERIVIATION OF A_2 MATRIX, AND DATA SOURCES USED FOR THE CONSTRUCTION OF THE INTERINDUSTRY AND HUMAN RESOURCE ACCOUNTS

TABLE LI

THE MOP AND CDS SECTOR CLASSIFICATION

The MOP Classification		The CDS Classification	
No.	Sector	No.	Sector
1.	Agriculture	1.	Agriculture
2.	Food, Drinks & Tobacco	2.	Mining
3.	Textile Industries.	3.	Manufacturing industries (excluding refined oil)
4.	Wood, Paper & Printing	4.	Refined Oil
5.	Crude & Refined Oil	5.	Electricity, Gas, Water
6.	Chemical Industry	6.	Construction
7.	Other Non-Mettalic Minerals	7.	Trade
8.	Metal, Industries, Basic Fabricated	8.	Transport and Comms.
9.	Other Manufacturing Inds.	9.	Financial services.
10.	Electricity	10.	Commuity and Personal Services
11.	Water Supply	11.	Government Services
12.	Civil Construction	12.	Other Services
13.	Building Construction		
14.	Industrial Construction		
15.	Sub-Contract Construction		
16.	Whole Sale Trade		
17.	Retail Trade		
18.	Hotels & Catering		
19.	Land Transport		
20.	Other Transport & Communications		
21.	Banking & Finance		
22.	Property Ownership		
23.	Other Business Services		
24.	Personal & Miscellaneous.		
25.	Household Repairs		
26.	Social & Community Services		

TABLE LII

EAS AND ISIC CLASSIFICATION

EAS Classification Used	ISIC Classification		
	Div.	Maj. Group	Title
Private Sectors:			
1. Agriculture, etc.	11		Agriculture & Hunting
		111	Agricultural and livestock production
		112	Agricultural services
		113	Hunting, trapping and game propagation
	12		Forestry and Logging
		121	Forestry
		122	Logging
	13	130	Fishing
2. Oil	22	220	Crude Petroleum and Natural Gas Production
		353	Petroleum refineries
		354	Manufacture of miscellaneous products of petroleum and coal
3. Mining	21	210	Coal Mining
	23	230	Metal Ore Mining
	29	290	Other Mining
4. Manufacturing	31		Manufacture of Food, Beverages and Tobacco
		311-312	Food manufacturing
		313	Beverage industries
		314	Tobacco manufactures
	32		Textile, Wearing Apparel and Leather Industries
		321	Manufacture of wearing apparel, except footwear
		323	Manufacture of leather and products of leather, leather substitutes and fur, except footwear and wearing apparel
		324	Manufacture of footwear, except vulcanized or moulded rubber or plastic footwear

TABLE LII (Continued)

EAS Classification Used	ISIC Classification Div.	Maj. Group	Title
Private Sectors:			
	33		Manufacture of Wood and Wood products, Including furniture
		331	Manufacture of furniture and fixtures, except primarily of metal
	34		Manufacture of Paper and Paper Products, Printing and Publishing
		341	Manufacture of paper and paper products
		342	Printing, publishong and allied industries
	35		Manufacture of Chemicals and Chemical, Petroleum, Coal, Rubber and Plastic Products
		351	Manufacture of industrial chemicals
		352	Manufacture of other chemical products
		355	Manufacture of rubber products
		356	Manufacture of plastic products not elsewhere classified
	36		Manufacture of Non-Metallic Mineral Products, except Products of Petroleum and Coal
		361	Manufacture of pottery, china and earthenware
		362	Manufacture of glass and glass products
		369	Manufacture of other non-metallic mineral products
	37		Basic Metal Industries
		371	Iron and steel basic industries
		372	Non-ferrous metal basic industries
	38		Manufacture of Fabricated Metal Products, Machinery and Equipment

TABLE LII (Continued)

EAS Classification Used	ISIC Classification		
	Div.	Maj. Group	Title
Private Sectors:			
		381	Manufacture of fabricated products, except machinery and equipment
		382	Manufacture of machinery except electrical
		383	Manufacture of electrical machinery apparatus, appliances and supplies
		384	Manufacture of transport equipment
		385	Manufacture of professional and scientific and measuring and controlling equipment not elsewhere classified, and of photographic and optical goods
	39	390	Other Manufacturing Industries
5. Utilities	41	410	Electricity, Gas and Steam
	42	420	Water Works and Supply
6. Construction	50	500	Construction
7. Trade and Commerce	61	610	Wholesale Trade
	62	620	Retail Trade
	63		Restaurants and Hotels
		631	Restaurants, cafes and other eating and drinking places
		632	Hotels, rooming houses, camps and other lodging places
8. Transport and Communications	71		Transport and Storage
		711	Land transport
		712	Water transport
		713	Air transport
		719	Services allied to transport
	72	720	Communication

TABLE LII (Continued)

EAS Classification Used	ISIC Classification		
	Div.	Maj. Group	Title
Private Sectors:			
9. Finance, etc.[1]	81	810	Financial Institutions
	82	820	Insurance
	83		Real Estate and Business Services
		831	Real estate[1]
		832	Business services except machinery and equipment rental and leasing
		833	Machinery and equipment rental and leasing
10. Services	93		Social and Related Community Services
		931	Education service (private)
		935	Business, professional and labour associations
		939	Other social and related community services
	94		Recreational and Cultural Services
		942	Libraries, museums, botanical and zoological gardens, and other cultural services not elsewhere classified
		949	Amusement and recreational services not elsewhere classified
	95		Personal and Household Services
		951	Repair services not elsewhere classified
		952	Laundries, laundry services and cleaning and dyeing plants
		953	Domestic services
		959	Miscellaneous personal services
	96	960	International and Other Extra-Territoral Bodies

TABLE LII (Continued)

EAS Classification Used	ISIC Classification Div.	Maj. Group	Title
Government Sector:	91	910	Public Administration and Defense
		911[1]	General public services
		912[1]	Defense
		913[1]	General administration, economic policies and services
		914[1]	General administration, health policies and services
		915[1]	Administration, social security and assistance
		916[1]	Administration, housing and community development policies and services
	92	920	Sanitary and similar services (public health)
	93	930	Medical, Dental, other health and veterinary services
		931	Education services
		932	Research and scientific institutes
		934	Welfare institutions

[1]The categories shown as sub-divisions of public administration and defence do not occur in the ISIC. These categories are defined in Table 5.3 on pp. 87-89 of the United Nations, A System of National Accounts, UN, New York, 1968. Otherwise, all the major divisions, divisions and major groups and the code number and title of each category are from the International Standard Industrial Classification of all Economic Activity (ISIC), Series M. No. 4. Rev. 2. United Nations, New York, 1968. The composition of each of the categories is defined in that publication.

MATHEMATICAL DERIVATION OF A_2 MATRIX

The system of equations which will represent the input-output table of Saudi Arabia are as follow:

Notations:

x_i = Gross output of the ith sector fo the endogenous sector where $i = 1,2,---10$

x_{ij} = Purchases of the jth endogenous sector from the ith endogenous sector needed to produce x_i output, where $j = 1,2,---10$

PC_i = Amount consumed by private consumption of the output of sector i

GC_i = Amount consumed by government consumption of the output of sector i

GCF_i = Amount invested by sector i

Exp_i = Amount exported by sector i

X_{pj} = Purchases from the primary input sector by the endogenous sector j

The output balance equations for the endogenous sectors are:

$$x_{11} + x_{12} + --- + x_{1,j} + --- + PC_1 + GC_1 + GCF_1 + EXP_1 = X_1$$

$$x_{21} + x_{22} --- + x_{2,j} + --- + PC_2 + GC_2 + GCF_2 + EXP_2 = X_2$$

$$x_{i,1} + x_{i,2} --- + x_{i,j} + --- + PC_i + GC_i + GCF_i + EXP_i = X_i \quad (1.A)$$

$$x_{10,1} + x_{10,2} --- + x_{10,j} + --- + PC_{10} + GC_{10} + GCF_{10} + EXP_{10} = X_{10}$$

The input balance equations for the exogenous sectors are:

$$x_{11} + x_{21} + --- + x_{i,1} + --- + x_{10,1} + x_{p,1} = x_1$$

$$x_{12} + x_{22} + --- + x_{i,2} + --- + x_{10,2} + x_{p,2} = x_2$$

$$x_{1j} + x_{2j} + --- + x_{ij} + --- + x_{10,j} + x_{p,j} = x_j$$

$$x_{1,10} + x_{2,10} + --- + x_{i,10} + --- + x_{10,10} + x_{p,10} = x_{10} \quad (2.A)$$

The right hand side of each equation in set (1.A) must be equal to the right hand side of each equation in set (2.A)

From equation set (1.A), the direct coefficient will be determined as:

$$a_{ij} = \frac{x_{ij}}{x_j} \qquad (3.A)$$

or

$$x_{ij} = a_{ij}x_j$$

Replace the value of x_{ij} in equation (3.A) into set (1.A).

$$a_{11}x_1 + a_{12}x_2 + \text{---} + a_{1j}x_j + \text{---} + a_{1,10}x_{10} + PC_1 + GC_1 + GCF_1 + EXP_1 = x_1$$

$$a_{i1}x_1 + a_{i2}x_2 + \text{---} + a_{ij}x_j + \text{---} + a_{i,10}x_{10} + PC_i + GC_i + GCF_i + EXP_i = x_i$$

$$a_{10,1}x_1 + a_{10,2}x_2 + a_{10,j}x_j + \text{---} + a_{10,10}x_{10} + PC_{10} + GC_{10} + GCF_{10} + EXP_{10} = x_{10}$$

In a matrix from this will be represented as:

$$\begin{vmatrix} a_{11} & a_{12} & a_{ij} & a_{i,10} \\ \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot \\ a_{i,1} & a_{i,2} & a_{ij} & a_{i,10} \\ \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot \\ a_{10,1} & a_{10,2} & a_{10,j} & a_{10,10} \end{vmatrix} - \begin{vmatrix} x_1 \\ \cdot \\ \cdot \\ x_i \\ \cdot \\ \cdot \\ x_{10} \end{vmatrix} + \begin{vmatrix} PC1 & GC1 & GCF1 & EXP1 \\ \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot \\ PCi & GCi & GCFi & EXPi \\ \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot \\ PC10 & GC10 & GCF10 & EXP10 \end{vmatrix} = \begin{vmatrix} x_1 \\ \cdot \\ \cdot \\ x_i \\ \cdot \\ \cdot \\ x_{10} \end{vmatrix}$$

or A_1 - x + y = x

where A_1 is the direct coefficient matrix

x is column vector of output
y is column vector of final demand

The direct and indirect coefficient Matrix A_2 will be determined as follows:

$$y = x - A_1x$$
$$y = x(I-A_1)$$
$$x = (I-A_1)^{-1}\, y$$
$$x = A_2y$$

Where I is an identy matrix with the same dimension as A_1

OCCUPATION CLASSIFICATION

Major Group 1 - Professional, Technical and Related Workers

Workers in this major group conduct research and apply scientific knowledge to the solution of a variety of technological, economic, social and industrial problems and perform other professional, technical, artistic and related functions in such fields as the physical and natural sciences, engineering, law, medicine, religion, education, literature, art, entertainment and sport.

They are classified in the minor groups listed below:
Phyusical scientists and related technicians
Architects, engineers and related technicians
Aircraft and ships' officers
Life scientists and related technicians
Medical, dental, veterinary and related workers
Statisticians, methematicians, systems analysts and related technicians
Economists
Accountants
Jurists
Teachers
Workers in religion
Authors, journalists and related writers
Sculptors, painters, photographers and related creative artists
Composers and performing artisist
Athletes, sportsment and related workers
Professional, technical and related workers not elsewhere classified.

Major Group 2 - Administrative and Managerial Workers

Workers in this major group comprise persons who as elected or appointed memebers of national, state, provincial or local governments are mainly occupied in deciding or participating in formulating governmental policy and in making and amending laws and official regulations, together with those who, as government administrators, organize and direct the interpretation and execution of governmental policy and those who, as directors and managers, plan, organize, coordinate and direct the activities of private or public enterprises or organizations or one or more of their departments.

They are classified in the minor groups listed below:
Legislative officieals and governemnt administrators
Managers

Major Group 3 - Clerical and Related Workers

Workers in this major group put into effect laws, rules and regulations made by central, state, provincial or local governments; supervise clerical and related work, transport and communications service operations; complie and maintain records of financial and other business transactions; handle cash on behalf of an organization and its

customers; record oral or written matter by shorthand writing, typing and other means; operate office machines and telephone and telegraph equipment, conduct passenger transport vehicles; take part in postal work and mail distribution and perform other duties related to the foregoing.

They are classified in the minor groups listed below:
Clerical supervisors
Government executive officials
Stenographers, typists and card and tape punching machine operators
Bookkeepers, cashiers and related workers
Computing machine operators
Transport and communications supervisors
Transport conductors
Mail distribution clerks
Telephone and telegraph operators
Clerical and related workers not elsewhere classified

Major Group 4 - Sales Workers

Workers in this major group are engaged in, or directly associated with, buying and selling goods and services of all kinds and in conducting wholesale and retail businesses on their own behalf or managing them on behalf of others.

They are classified in the minor groups listed below:
Managers (wholesale and retail trade)
Working proprietors (wholesale and retail trade)
Sales supervisors and buyers
Technical sales men, commercial travellers and manufacturers' agents Insurance, real estate, securities and business services salesmen and auctioneers
Salesmen, shop assistants and related workers
Sales workers not elsewhere classified

Major Group 5 - Service Workers

Workers in this major group direct, organize, supervise or perform catering, housekeeping, personal, protective and related services.

They are classified in the minor groups listed below:
Managers (catering and lodging services)
Working proprietors (catering and lodging services)
Housekeeping and related service supervisors
Cooks, waiters, bartenders and related workers
Maids and related housekeeping service workers not elsewhere classified
Building caretakers, charworkers, cleaners and related workers
Launderers, dry-cleaners and pressers
Hairdressers, barbers, beauticians and related workers
Protective service workers
Service workers not elsewhere classified

Major Group 6 - Agricultural, Animal Husbandry and Forestry Workers, Fishermen, and Hunters

Workers in this major group manage farms or conduct them on their own behalf or in partnership, supervise or perform agricultural, animal husbandry and forestry tasks, catch fish, hunt and trap animals, and perform related tasks.

They are classified in the minor groups listed below:
Farm managers and supervisors
Farmers
Agricultural and animal husbandry workers
Forestry workers
Fishermen, hunters and related workers

Major Group 7 - Production and Related Workers, Transport Equipment Operators and Laborers

Workers in this major group are engaged in or directly associated wiht the extraction of mineals, petroleum and natural gas from the earth and their treatment; manufacturing processes; the construction, maintenance and repair of various types of roads, structures, machines and other products. Also included are those who handle materials, operatate transport an dother equipment and perform labouring tasks requiring primarily physical effort.

They are classified in the following minor groups:
Production supervisors and general foremen
Miners, quarrymen, well-drillers and related workers
Metal processers
Wood preparation workers and paper makers
Chemical processers and related workers
Spinners, weavers, knitters, dyers and related wokers
Tanners, fellmongers and pelt dressers
Food and beverage processers
Tobacco preparers and tobacco product makers
Tailers, dressmakers, sewers, upholsterers and related workers
Shoemakers and leather goods makers
Cabinetmakers and related woodworkers
Stone-cutters and carvers
Blacksmiths, toolmakers and machine tool operators
Machinery fitters, machine assemblers and precision instrument workers (except electrical)
Electrical fitters and related electrical and electronics workers
Broadcasting station and sound equipment oeprators and cinema projectionists
Plumbers, welders, sheet metal and structural metal preparers and erectors
Jewelry and precious metal workers
Glass formers, potters and related workers
Rubber and plastics product makers
Paper and paperboard products makers
Printers and related workers
Painters

Production and related workers not elsewhere classified
Bricklayers, carpenters and other construction workers
Stationary engine and related equipment oeprators
Material handling and related equipment oeprators, dockers and freight handlers
Transport equipment oeprators
Labourers not elsewhere classified

SOURCE OF DATA

The information needed for this research are gathered from various public and private sources, by various means, such as personal interview, publication, inside and outside Saudi Arabia, mainly the United States.

1. In the United States

A general library search at Oklahoma State University and other universitites through inter-library loan and through on-line search was conducted to gather information about the development and imporvement of the application of the technique. The United Nations publication as well as other government publications were used to obtain the relevant information needed.

A trip to Houston, Texas, to visit the library of the Saudi Arabian educational mision was conducted in May, 1982. This library contains most of the research done on Saudi Arabia by the Saudia students in the United States as well as other sources of Saudi Arabian governemnt publications.

2. In Saudi Arabia

The information was gathered mainly from the government ministries and agencies. The most important source of information concerning this research was gathered from the following ministries and governement agencies:

1. Ministry of Planning
2. Ministry of Labor
3. Ministry of Commerce
4. Ministry of Industrial and Electricity

5. Ministry of Agriculture
6. Ministry of Housing and Public Works
7. Ministry of Petroleum and Mineral
8. Ministry of Finance and National Economy
9. General Directors of Ports
10. ARAMCO
11. Saudi Industrial Development Funds
12. Central Department of Statistics
13. Industrial Studies and Development Center

APPENDIX B

DATA NEEDED FOR THE IMPLEMENTATION OF THE MANPOWER REQUIREMENT MODEL WHICH ARE NOT PRESENTED IN THE MAIN BODY OF THIS DESSERTATION

TABLE LIII

(SCENARIO A) THE PROJECTED VALUES OF THE DEPENDENT VARIABLES IN THE FINAL DEMAND MODEL 1976-1990 (IN MSR)

Year	PC	GC	IM	GCF	EXP
1976	26562	25399	38954	31313	108712
1977	36909	42087	56668	45948	126446
1978	50981	53620	84537	67202	125998
1979	69429	59003	111367	78987	182842
1980	86177	91704	136776	97338	253089
1981	98953	106498	162485	119571	259270
1982	109017	122283	181008	133238	265599
1983	117835	135469	197004	145040	272080
1984	126249	146296	211627	155828	278716
1985	134718	155140	225598	166136	285512
1986	143485	162399	239370	176297	292471
1987	152692	168433	253254	186541	299596
1988	162424	173545	267469	197029	306893
1989	172746	177973	282183	207885	314365
1990	183708	181905	297529	219207	322016

TABLE LIV

(SCENARIO B) THE PROJECTED VALUES OF THE DEPENDENT VARIABLES IN THE FINAL DEMAND MODEL 1976-1990 (IN MSR)

Year	PC	GC	IM	GCF	EXP
1976	26562	25399	38954	31313	108712
1977	36909	42087	56668	45949	126446
1978	50981	53620	84537	67202	125998
1979	69429	59003	111367	78987	182842
1980	86177	91704	136776	97338	253089
1981	100570	107065	164744	121238	258240
1982	116229	124059	190809	140469	263493
1983	132117	139069	216443	159382	268852
1984	149034	152259	242720	178769	274318
1985	167526	163919	270439	199220	279893
1986	188006	174370	300240	221208	285579
1987	210832	183908	332687	245147	291380
1988	236348	192791	368310	271430	297296
1989	264909	211226	407634	300444	303331
1990	296900	209382	451211	332595	309486

TABLE LV

(SCENARIO C) THE PROJECTED VALUES OF THE DEPENDENT VARIABLES IN THE FINAL DEMAND MODEL 1976-1990 (IN MSR)

Year	PC	GC	IM	GCF	EXP
1976	26562	25399	38954	31313	108712
1977	36909	42087	56668	45949	126446
1978	50981	53620	84537	67202	125998
1979	69429	59003	111367	78987	182842
1980	86177	91704	136776	97338	253089
1981	96900	107667	160305	117963	264935
1982	106067	125961	178604	131464	281764
1983	113293	142970	193971	142802	294725
1984	119654	158815	207816	153017	303845
1985	125715	173724	220940	162670	318026
1986	131767	187962	233808	172194	332859
1987	137958	201785	246701	181706	348375
1988	144366	215422	259801	191372	364605
1989	151037	229069	273240	201287	381580
1990	157998	242893	287111	211521	399337

TABLE LVI

(SCENARIO D) THE PROJECTED VALUES OF THE DEPENDENT VARIABLES IN THE FINAL DEMAND MODEL 1976-1990 (IN MSR)

Year	PC	GC	IM	GCF	EXP
1976	26562	25399	38954	31313	108712
1977	36909	42087	56668	45949	126446
1978	50981	53620	84537	67202	125998
1979	69429	59003	111367	78987	182842
1980	86177	91704	136776	97338	253089
1981	99276	108760	163718	120481	270086
1982	112582	129460	181474	138505	288205
1983	125227	150276	211780	155941	307519
1984	138056	171342	235736	173616	328108
1985	151576	192884	260744	192067	350056
1986	166104	215168	287301	211661	377890
1987	181868	238474	315799	232687	398393
1988	199045	263086	346566	255387	424980
1989	217804	289284	379919	279995	453322
1990	238311	317343	416169	306741	483534

TABLE LVII

THE FINAL DEMAND COEFFICIENTS MATRIX
FOR THE BASE YEAR 1976

Sector	PC	GC	GCF	EXP
Agriculture	0.23726	0.00019	0.00003	0.00243
Oil	0.02495	0.04033	0.00179	0.90089
Mining	0.00032	0.00115	0.02263	0.000
Manufacturing	0.06103	0.12137	0.05133	0.00596
Utility	0.01354	0.01529	0.0	0.0
Construction	0.00911	0.27943	0.83486	0.0
Trade	0.43465	0.13570	0.04442	0.03280
Transport	0.05276	0.22525	0.01737	0.03910
Finance	0.10971	0.10818	0.02759	0.01797
Service	0.05932	0.07320	0.0	0.00085

TABLE LVIII

THE ANNUAL RATE OF CHANGE OF PRODUCTIVITY ESTIMATED BY THE MODEL AND BY THE MOP

Sector	The Model Estimated Rate of Change in Productivity 1981-1990	The MOP Estimated Rate of Change in Productivity 1981-1990[1]
Agriculture	0.047	0.080
Oil	0.029	0.000[2]
Mining	0.063	0.035
Manufacturing	0.057	0.085
Utility	0.085	0.085[3]
Construction	0.063	0.035
Trade	0.056	0.065
Transport	0.048	0.075
Finance	0.057	0.020
Service	0.054	0.020

[1]The MOP estimates have been extended to the year 1990 to cover the period under study by this research.

[2]The MOP has not furnished an estimate.

[3]The estimate furnished by the MOP, 0.195 seems to be exaggerated. Thus, the second highest estimate, 0.085 is used.

TABLE LIX

VECTOR AND SCALARS WHICH ARE NEEDED FOR THE IMPLEMENTATION OF THE MANPOWER REQUIREMENT MODEL AND NOT PRESENTED ELSEWHERE

$[FLO]_{1980}$	FL_{1980}	a_1	a_2
136.714	1059.8	1.0520	1.0199
15.897			
158.970			
147.312			
189.704			
412.262			

TABLE LX

THE ESTIMATED GROWTH OF THE INDEPENDENT VARIABLES IN ALL FOUR SCENARIOS

	A	B	C	D
No GDP	6.20	11.80	4.5	9.2
GR	1.34	3.20	5.2	8.9
WOC	2.40	2.00	4.6	6.6

APPENDIX C

ANALYSIS OF ALL THE SCENARIOS UNDER THE SECOND SET OF PRODUCTIVITY

TABLE LXI

THE DIRECT AND INDIRECT EMPLOYMENT PER ONE MSR DELIVERIES TO FINAL DEMAND UNDER THE SECOND SET OF PRODUCTIVITY IN 1985 AND 1990

Sector	Year	1	2	3	4	5	6	7	8	9	10
Agriculture	1985	19.20021	0.00038	0.00077	0.00115	0.00173	0.00058	0.00058	0.01361	0.00019	0.00038
	1990	13.00225	0.00026	0.00052	0.00078	0.00117	0.00039	0.00039	0.00922	0.00013	0.00026
Oil	1985	0.00078	0.15219	0.00086	0.00085	0.00667	0.00116	0.00040	0.00381	0.00023	0.00267
	1990	0.00078	0.15219	0.00086	0.00085	0.00667	0.00116	0.00040	0.00381	0.00023	0.00267
Mining	1985	0.00002	0.00126	0.79468	0.00381	0.00225	0.03458	0.00027	0.00387	0.00026	0.00056
	1990	0.00002	0.00106	0.66847	0.00320	0.00190	0.02908	0.00023	0.00326	0.00022	0.00047
Manufacturing	1985	0.00427	0.01544	0.12258	2.45323	0.07360	0.05975	0.00731	0.04337	0.00332	0.04221
	1990	0.00285	0.01029	0.08167	1.63451	0.04903	0.03981	0.00487	0.02890	0.00221	0.02812
Utility	1985	0.00017	0.00702	0.08561	0.02753	5.60994	0.02034	0.00975	0.01850	0.00624	0.03751
	1990	0.00011	0.00468	0.05704	0.01834	3.73773	0.01355	0.00650	0.01233	0.00416	0.02499
Construction	1985	0.00028	0.00954	0.01564	0.05426	0.06268	2.44222	0.01411	0.25984	0.01386	0.01831
	1990	0.00023	0.00802	0.01316	0.04564	0.05273	2.05431	0.01187	0.21857	0.01165	0.01540
Trade	1985	0.02504	0.00727	0.15179	0.23139	0.25357	0.10802	3.19189	0.14274	0.01260	0.11764
	1990	0.01828	0.00531	0.11081	0.16891	0.18511	0.07885	2.33010	0.10420	0.00920	0.08587
Transport	1985	0.00150	0.06260	0.13419	0.08210	0.34235	0.07212	0.13034	3.10522	0.02628	0.05933
	1990	0.00105	0.04355	0.09335	0.05712	0.23817	0.05107	0.09068	2.16024	0.01828	0.04127
Finance	1985	0.00141	0.01061	0.01450	0.03443	0.04623	0.06123	0.02313	0.04350	0.67579	0.03156
	1990	0.00128	0.00959	0.01311	0.03112	0.04178	0.05535	0.02091	0.03932	0.61084	0.02852
Service	1985	0.00153	0.20377	0.11688	0.12698	0.15665	0.07802	0.04712	0.10036	0.01101	30.67525
	1990	0.00996	0.18420	0.10565	0.11478	0.14160	0.07053	0.04259	0.09071	0.00996	27.72802

TABLE LXII

THE EMPLOYMENT EFFECTS OF THE BACKWARD AND FORWARD LINKAGE
UNDER THE SECOND SET OF PRODUCTIVITY IN 1985

Backward Linkage					Forward Linkage			
Total 1	Direct 2	Indirect 1-2	$1\text{-}2/2$	Rank	Total 6	Indirect 6-2	$6\text{-}2/2$	Rank
19.23521	19.20021	0.03500	0.00182	10	19.21957	0.01936	0.00101	10
0.47008	0.15279	0.31789	2.08877	1	0.16961	0.01742	0.11446	6
1.43750	0.79468	0.64282	0.80890	2	0.84157	0.04689	0.05900	7
3.01573	2.45323	0.56250	0.22929	3	2.82507	0.37184	0.15157	5
6.55567	5.60994	0.94573	0.16858	6	5.82262	0.21268	0.03791	8
2.87802	2.44222	0.43580	0.17844	5	2.89074	0.44852	0.18365	4
3.43482	3.19189	0.23301	0.07300	8	4.24192	1.05003	0.32897	2
3.73482	3.10522	0.62960	0.20276	4	4.01603	0.98081	0.29332	3
0.74978	0.67579	0.07399	0.10949	7	0.94240	0.26661	0.39452	1
30.98542	30.67525	0.31017	0.01011	9	31.51758	0.84236	0.02746	9

TABLE LXIII

EMPLOYMENT BY OCCUPATION IN EACH SECTOR PER ONE MSR UNDER THE SECOND SET OF PRODUCTIVITY IN 1985 AND 1990

Sector	Year	Professional and Technical	Administrative and Managerial	Clerical	Sales	Services	Agriculture	Production
Agriculture	1985	0.88852	0.23698	0.99211	1.05131	0.50336	11.24595	4.30153
	1990	0.60170	0.16048	0.67185	0.71194	0.34087	7.61568	2.91297
Oil	1985	0.02323	0.00373	0.00509	0.02459	0.01018	0.0	0.10279
	1990	0.02323	0.00373	0.00509	0.02459	0.01018	0.0	0.10279
Mining	1985	0.05560	0.01899	0.07322	0.00506	0.01153	0.10971	0.56746
	1990	0.04677	0.01598	0.06159	0.00425	0.00970	0.09228	0.47733
Manufacturing	1985	0.10515	0.07472	0.10845	0.14221	0.06851	0.00249	2.32350
	1990	0.07006	0.04979	0.07226	0.09475	0.04564	0.00166	1.54808
Utility	1985	0.74070	0.04804	1.10641	0.04338	0.34342	0.00786	3.53282
	1990	0.49350	0.03201	0.73717	0.02890	0.22881	0.00524	2.35381
Construction	1985	0.20247	0.05883	0.14801	0.02174	0.14217	0.00515	2.31236
	1990	0.17031	0.04948	0.12450	0.01829	0.11959	0.00433	1.94507
Trade	1985	0.17366	0.08891	0.31458	2.26171	0.70598	0.01930	0.67777
	1990	0.12678	0.06491	0.22965	1.65107	0.51537	0.01409	0.49478
Transport	1985	0.35136	0.13546	0.54453	0.06466	0.33088	0.01141	2.57769
	1990	0.24444	0.09424	0.37882	0.04498	0.23019	0.00793	1.79325
Finance	1985	0.179290	0.07676	0.37957	0.12660	0.07399	0.00859	0.10397
	1990	0.15629	0.06938	0.34309	0.11444	0.06688	0.00777	0.09397
Services	1985	0.31297	0.61995	1.68304	1.73630	9.00615	0.20991	11.94926
	1990	5.70643	0.56039	1.52133	1.56948	8.14085	0.18974	10.80119

TABLE LXIV

EMPLOYMENT BY EDUCATION IN EACH SECTOR PER ONE MSR UNDER THE THIRD SET OF PRODUCTIVITY IN 1985 AND 1990

Year	Advanced Study	University Degree	Some University	Technical High School	General High School	Intermediate School	Primary School	Read and Write	Illiterate
1985	0.04440	1.25869	0.09829	0.91062	0.44416	0.54795	0.42937	4.06456	11.42373
1990	0.03007	0.85238	0.06521	0.61667	0.30079	0.37107	0.29076	2.75249	7.73607
1985	0.00107	0.02449	0.01230	0.02230	0.02424	0.02607	0.01785	0.03623	0.00514
1990	0.00107	0.02449	0.01230	0.02230	0.02424	0.02607	0.01785	0.03623	0.00514
1985	0.00358	0.06743	0.04816	0.14471	0.04730	0.11867	0.17290	0.17939	0.05944
1990	0.00301	0.05672	0.04051	0.12172	0.03978	0.09982	0.14544	0.15090	0.05000
1985	0.00568	0.08136	0.05611	0.07458	0.10919	0.15128	0.18897	1.17811	0.97982
1990	0.00378	0.05421	0.03738	0.04969	0.07275	0.10079	0.12590	0.78494	0.65282
1985	0.02230	0.49411	0.19011	0.40106	0.57854	0.47705	0.84760	1.37909	1.43277
1990	0.01486	0.32921	0.12666	0.26722	0.38546	0.31784	0.56473	0.91884	0.95461
1985	0.00893	0.15613	0.06091	0.11748	0.25589	0.24435	0.28387	1.13346	0.62969
1990	0.00751	0.13133	0.05123	0.09882	0.21524	0.20554	0.23878	0.95342	0.52967
1985	0.00942	0.15780	0.10045	0.07254	0.25010	0.33630	0.37622	1.81762	1.12148
1990	0.00687	0.11519	0.07333	0.05295	0.18258	0.24550	0.27464	1.32688	0.81869
1985	0.03004	0.33000	0.12269	0.18381	0.63618	0.36839	0.35554	1.19344	0.79594
1990	0.01090	0.22957	0.08535	0.12788	0.44258	0.25628	0.24734	0.83026	0.55372
1985	0.01535	0.18573	0.04873	0.03080	0.17203	0.09736	0.08706	0.21590	0.08944
1990	0.01388	0.16788	0.04405	0.02784	0.15549	0.08800	0.07869	0.19516	0.08085
1985	0.49955	2.21884	1.20681	1.30073	1.79963	3.56905	3.86973	9.05468	8.00105
1990	0.45156	2.00565	1.09086	1.17576	1.62675	3.22614	3.49793	8.18472	7.23232

VITA 2

Mohammed S. A. Aljiffry

Candidate for the Degree of

Doctor of Philosophy

Thesis: MANPOWER PROJECTION MODEL FOR ECONOMIC PLANNING IN SAUDI ARABIA USING THE INPUT-OUTPUT TECHNIQUE

Major Field: Industrial Engineering and Management

Biographical:

Personal Data: Born in Mecca, Saudi Arabia, in 1954.

Education: Bachelor of Science degree in Industrial Engineering and Management from Oklahoma State University in 1977; received Master of Science Degree from Oklahoma State University in 1978; completed requirements for Doctor of Philosophy degree at Stillwater, Oklahoma, in December 1983.

Professional Experience: Graduate Teaching Assistant, School of Industrial Engineering and Management, Oklahoma State University, 1977-1978. Lectural at the University of King Abdulaziz in Jeddah, Saudi Arabia (on Study Leave of Absence), 1979 to Present. Graduate Teaching Assistant to the School of Industrial Engineering and Management, Oklahoma State University, 1980-1982.