THE RELATIONSHIP BETWEEN TECHNOLOGICAL CHANGE AND ECONOMIC GROWTH IN IRAQ

"An Analysis of Technology Transfer in Iraq for the Period 1960-1978: A Production Function Approach is Used and Relationships Between Technology Transfer and Economic Growth Identified."

By

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ABSTRACT

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Keywords: *Technical Change, Technology Transfer, Economic Growth, Aggregate Sectoral Levels, Production Function, Input Factors, Output.*

In this study an attempt has been made to explore the role of technology transfer in the economic growth of Iraq, through the change in the technology itself for the period 1960–1978. For this purpose the economy was disaggregated into seven sectors.

The experience of developed countries has shown that technical change is one of the most important factors of economic growth alongside, or even overshadowing, such factors as labour and capital.

In the light of technology transfer, developing countries have the advantage of introducing high levels of advancement of knowledge which can be used to induce domestic technical change at later stages.

Technical change is normally defined as a shift in the production function, and for this reason two forms of production function were estimated and tested, i.e. the constant elasticity of substitution and the Cobb-Douglas function. Also two specifications (constant and variable) were assigned to technical change. To validate the use of these, statistical tests were conducted to establish the optimum fit. Then the selected form was used to simulate output levels for comparison with actual figures. The techniques used for estimation are both linear and non-linear. Data used are time series in real terms of capital stock and output, as well as number of persons employed.

Furthermore in order to judge the importance of technical change to the growth of output on aggregate and sectoral levels, as regards economic growth, comparisons were drawn with existing data from other developed and developing countries, including centrally planned economies.

DEDICATION

To my wonderful parents, my patient wife, my beautiful daughters, and my inspiring brother.

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INTRODUCTION

1.1 BACKGROUND

The republic of Iraq has had tremendous economic growth, as a result of which, its gross domestic product in real terms grew at 7.8 per cent per year during the period 1960-1978, and the rate of growth of manufacturing increased annually by 10.0 per cent. This is one of the highest and best sustained growth rates in the developing countries.*

What are the factors contributing to such rapid economic growth in Iraq? The answer is indeed not easy since there are numerous and various forces interacting to influence economic growth.

A number of hypotheses point to the causes of this speedy growth, such as the effect of the saving level, the effect of resources endowment, and the influence of economic policy. One important hypothesis about the causes of the high economic performance concerns the advancement of technology and one of the major directions for advancement of technology has been through transfer of technology. In spite of these important features, until now there has been no

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* *On aggregate level, this growth rate compare to 9.3 per cent in Hong-Kong, 8.8 per cent in Korea, and 10.1 per cent in Japan. These rates were achieved between 1950-1970.*

serious attempt to quantify the overall impact of imported technology on the Iraqi economy and so this is one of the main reasons for tackling this important issue.

Because countries engage in research and development at different rates and because the diffusion of technology is neither immediate nor complete, some countries are more technologically advanced than others. Moreover, the latest technologies are concentrated in a few advanced countries.

Developing countries in their development effort must have access to such technology, otherwise the technological gap between them and developed countries will widen further. Acquiring such technology might be met by one of the following options: first, by spending an enormous amount on research and development (R & D) to produce their technologies or second, by importing it, i.e. through the process of technology transfer from those who already possess it.

Since technology required already exists there is no need for those technologically handicapped to re-invent the technologies – by doing so they would lose the advantages of being a *late comer*. Accordingly it seems logical for developing countries to acquire the technology needed from advanced countries. As a result of this the flow of technology has begun from developed to developing nations through different channels and for specified cost. Developing countries are limited by their Balance of Payments and indeed most of those countries have been affected very much by this constraint.

Iraq, as a developing country, in its drive for modernization is not very much constrained by its Balance of Payments (at least since the nationalisation of the interest of foreign oil companies in 1972 and the quadrupling of oil price in 1974). It has tried to take full advantages of being a *late comer* to overcome its technological backwardness. This can be verified by the massive transfer of technology through most of existing channels from the most advanced countries.

The importance of technology transfer in Iraqi development has been one of the most important issues for its leading political party. As stated in its central report of the ninth regional congress (1982) "To depend on only the nation's abilities undoubtedly means slow growth and losing out on opportunities which could lead to better prospects ... Thus it is imperative to make use of external sources with their experiences and skills, in the comprehensive development process." Moreover, the government has diversified the sources of technology which it has imported from many parts of the world, "in order to have access to the scientific and technical development experienced world wide."

1.2 PURPOSES OF THE STUDY.

The main purpose of this study is to present an analytical review of the role played by technology transfer in the economic growth of Iraq. The economy is aggregated into seven sectors: Agricultural; Manufacturing; Mining and Quarrying; Electricity, Gas and Water;

Construction; Distribution; and Services. Two forms of the production function are estimated for each of these sectors and for the economy, using time-series data for a period covering the years 1960 to 1978. Statistical tests are used for selecting the best estimate, which is used to analyse the role played by the different factors of production in the economic growth of output generated in these sectors and in the economy as a whole.

Historically, the role played by technology transfer has been studied by two different approaches; First by quantifying its role through measuring its agent, technical change. And second by comparing the difference between marginal productivity of imported technology and that of the domestically produced technology. However, the second approach is used in the case of technology transferred to countries which have a productive capacity for part of their technology requirement, while the first approach is suitable for analysing the role of technology transfer in a developing country in its first stage of development, when most of its technological change is mainly, if not totally, as a result of importing advanced technology.

In the general sense this means there would be no discrimination between the different types of existing technology, whether it is totally imported from abroad or totally produced domestically. Therefore, the second approach is used in this thesis since Iraq is a developing country and most of its technology is transferred from abroad.

This thesis does not stop at measuring the magnitude of the rate of growth of technical change in the economy and its seven sectors using only the second approach. It also attempts to measure the contribution from the rate of growth of technical change, to the growth of output.

More practically this study will answer four related questions:

First, what form of production function best fits the production process of the Iraqi economy on aggregate and sectoral levels?

Second, what is the rate of growth of technical change, the representative of technology transfer, in the economy and its sectors?

Third, what is the contribution made by technical change to the growth of output for the different sectors as well as the economy?

Fourth, what conclusions can be drawn and consequently what, if any, recommendations can be given?

Our analysis will be carried out within the framework of the neo-classical theory of the production function with two homogenous factor inputs, i.e. capital and labour. However, the function must satisfy the conditions of monitonicity and concavity. The first condition, monitonicity, means that the marginal productivity of any input must be positive, while concavity means that the second partial derivatives are less than or equal to zero.

For answering the first question two forms of production function, i.e. Constant Elasticity of Substitution (CES) and Cobb–Douglas (C-D), will be estimated. Techniques used for estimating those functional forms are non-linear and linear.

Data used for estimating the two production functions are series of gross domestic product and of capital stock in real terms with 1969=100. Also a series of labour force is used.

In answering the second question, technical change will be estimated under two assumptions:

First technical change grew during the period under study at a constant rate. Two approaches will be estimated, the first one is the indirect approach or what some refer to as a non-parametric approach. Within this approch Solow's and Kendrick indices will be estimated. And second the direct approach or the parametric approach. However, despite this initial obvious difference, the above approches are based on the same assumptions, and thus it will be possible to compare the results obtained from using them.

The second assumption is that technical change grew at a variable rate. Under this assumption technical change will be given two specifications: variable and continuous, and variable and discrete.

For answering the third question the sources of growth framework is utilized with a slight departure from the conventional approach by also taking into account the intervening years when calculating the rates of growth of the variables. This will allow us to find the changes in the contribution made by technical change to output in different subperiods, this also shows the patterns of development at sectoral and aggregate levels. That is, does the development of output rely on expansion of capital and labour inputs or on the technological change generated by technology transfer process?

This study in general will add to the existing evidence on transfer of technology experience of this country; particularly the contribution made from such transfer to the Iraqi development.

1.3 SOME LIMITATIONS OF THE STUDY.

It is important to put forward some of the limitations of the study. These are:

1. The scarcity or non-availability of certain types of data which is desperately needed, such as, number of working hours, the electricity consumption etc. This forced us to use what is available and this might not be the perfect choice.

2. The quality of data used might not be of the desirable level. Deficiencies in data will be pointed out in the thesis. Care was taken in compiling the time series used in the estimation, however, the non availability of good quality data is not an

individual problem in that most of developing countries have a lack of good data.

3. The high level of aggregation. In fact we initially attempted to disaggregate the economy even further but did not have access to such data.

4. The shortness of the period – this spans from 1960 to 1978, which is dictated by the availability of the data. However, most other studies on developing countries have based their analysis on a sample of a comparable period and some-times cover a period even shorter than ours.

Consequently some of the results should be interpreted with caution.

1.4 THE PLAN OF THE STUDY.

While this part of the study deals with the introduction, the rest of the thesis will be structured as follows: Chapter Two provides the required background information on the performance of the Iraqi economy in the period under considaration. The sectoral contribution of value–added, labour force and capital formation as well as the sectoral interrelationship will be the main focus of that chapter. Also the foreign trade role and the Balance of Payments will be outlined.

Chapter Three is devoted to technology transfer, technical change general concepts, and definitions. In this chapter, three main topics will be discussed, first the transfer of technology. its channels, and conditions necessary for effective transfer of technology, etc; second will be technical change, its definition, types etc; third is the interrelationship between technology transfer and technical change.

In chapter Four a review of the previous studies will be presented, concentrating on studies using the techniques used in this thesis.

Chapter Five outlines the production function theory, and the two models of the production measurement will be presented. The different methods used for measuring technical change will be described, as are types of data, quality, derivation and sources.

Chapter Six will summarize the empirical results, Solow's, Kendrick's and direct measurements along with their analysis. While chapter Seven describes the impact of technical change on the economic growth on both aggregate and sectoral levels.

Finally, chapter Eight will give the general conclusions of the analysis and policy implications of the results as well as further suggested directions for research in this area.

The study contains eight appendices. Appendix A for general basic data. Appendix B for data on the economy. While appendices C to I contain data on the sectoral levels.

CHAPTER TWO

THE IRAQI ECONOMY: AN OVERVIEW

2.1 INTRODUCTION

Iraq is a socialist, oil exporting, developing country. It is a medium-size country with an area of 438,317 square kilometres. Iraqi population has increased to more than 15 million in 1988 and growing at a high rate. In other words Iraq's area is 1.8 times that of U.K but its population is less than one third that of the U.K. Thus there is sizeable room for increasing its population.

Iraq's is an oil-dominated economy.* Oil revenues constitute the main source of development finance, accounting for the major proportion of foreign exchange, and contributing the largest share to gross domestic product. In 1960, oil accounted for more than 37 per cent of nominal gross domestic product, whereas in 1978 it accounted for more than 50 per cent of gross domestic product, a jump caused by the dramatic increase in oil prices in the last quarter of 1973. Moreover, "oil exports represent more than 95 per cent of total merchandise exports and about 85 per cent of central government budget receipts" (Abed and Kubursi, 1981).

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* *In addition to oil, Iraq has a number of other natural resources such as sulphur, Phosphate Rock etc. In fact, according to recent figures Iraq has the largest reserve in the world of sulphur. Its reserve estimated to be around 230 million tons (see ATH-Thawra international, March.23, 1988).*

The first comprehensive framework of national development in Iraq began after the overthrow of the monarchy and the liberation of the country from foreign control in 1958. Since that date the five years development plans were adopted and the Ministry of Planning was established for this purpose.*

Until 1972 the oil sector, which is the main financial source for the development plans, was under the control of the foreign oil companies operating in Iraq. The government share in the oil revenue according to what it called the "fifty-fifty" agreement was half of the annual profits from the export of crude oil, the other half went to the foreign oil companies.

On the first of July 1972 the Iraqi government nationalized the Iraqi Petroleum Company, (law no. 69 of 1972); this guaranteed governmental control of 65 per cent of the the oil production. Shortly after that total control of other foreign shares was achieved by nationalizing all other foreign shares in the oil companies operating in the country.† The full control of the oil sector associated with the oil price adjustments after 1973 enabled the government to accelerate the development process, especially through transferring highly advanced technologies into the country.

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* *The experience of development planning in Iraq extends back as early as 1927 when Iraqi government recieved its first oil revenue from foreign oil companies (see sayingh, 1977).*

† *Those shares are: American's in Basrah Oil Company (Law No. 70, 1973), Royal Ducth (Law No. 90, 1973), and Gulbenkian (Law No. 101, 1973).*

The purpose of this chapter is to give an overview of the Iraqi economy and its composition during the period studied. However, in the second section growth of gross domestic product will be disscussed, in the third section output structure, and in the fourth section the population structure. In the following two sections the labour force and the capital formation roles and their distribution among the different sectors will presented. In the seventh section national development planning and the role of the public sector will be discussed. Finally foreign trade's role in the Iraqi economy is outlined.

2.2 GROWTH OF GROSS DOMESTIC PRODUCT

The data on Iraq's economic growth performance is presented in table 2.1 and shown in figure (2.1) in terms of annual growth rates of Gross Domestic Product in 1969 constant prices for the period 1960–1978. Table 2.1 also shows the annual growth rates for different subperiods.

The most striking fact about the figures in table 2.1 is the high growth rates achieved after 1973. Also the high decline in 1963 which was the consequence of the intensive fighting in the north of the country, and the low level in 1967 because the oil export embargo on countries supporting Isreal in its war with the Arab countries during that year.

TABLE 2.1

Annual growth rates of the Gross Domestic Product, 1960–1978 and subperiods.

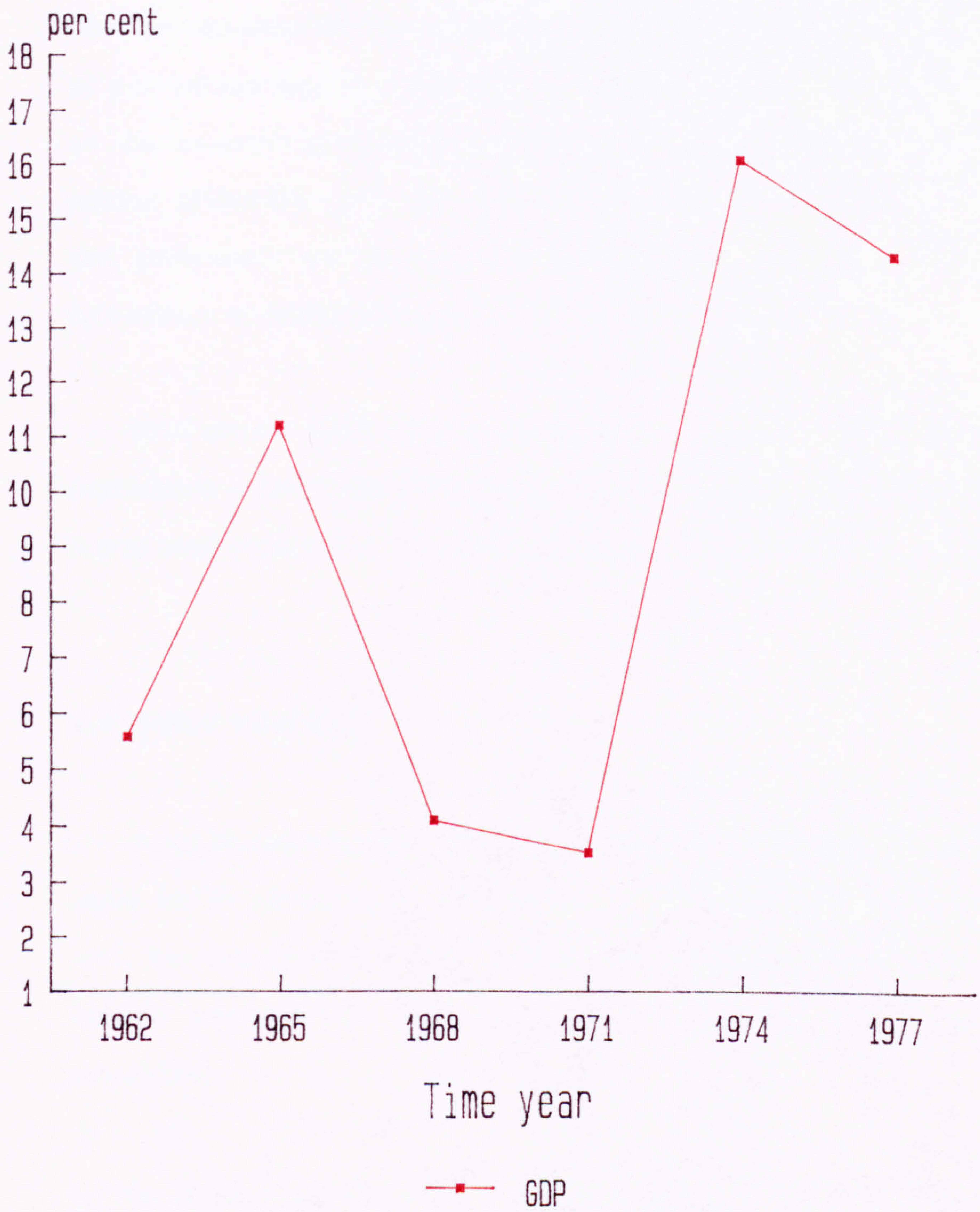
year	rate of growth
1960	----
1961	11.6
1962	5.7
1963	-0.6
1964	15.9
1965	13.6
1966	4.0
1967	-5.7
1968	15.6
1969	2.4
1970	1.3
1971	6.1
1972	3.2
1973	10.5
1974	10.2
1975	27.6
1976	14.5
1977	11.9
1978	16.6

period	average of annual rates	trend rate of growth
1960–1967	6.2	6.8 (7.42)
1968–1972	5.7	3.3 (7.66)
1973–1978	15.2	16.4 (17.6)
1960–1978	9.1	7.8 (15.8)

Notes:
1.All figures are in 1969 constant prices
2.In parenthesis are *t* ratios

Source:
table B.1 in appendix B.

figure **2.1**
Iraq GDP Growth Rates: 1960-1978



The annual growth rates are averaged over three years and plotted at the mid-year of each period.

Working with the trend rate of growth,* two points are worth mentioning; first, growth rate achieved during the period 1973–1978 was much higher than that of the previous subperiods. This might be the consequences of the oil price adjustment and the nationalization of oil on one hand and the pay off of the huge technology transferred to the country. And second, the low growth rate achieved during the period 1968–1972. This is surely the result of the conflict between the government and foreign oil companies on one hand and the high investment on infrastructure on the other.

This growth rate of gross domestic product is associated with a population growth rate of 3.2 per cent per annum. Thus there has been a per capita increase in income of nearly 5.4 per cent per annum.

2.3 OUTPUT STRUCTURE

In spite of the remarkable performance on aggregate level, there might be an imbalance growth among the different sectors. This point will be clarified in this section by finding the changes in the various contribution to the gross domestic product during different subperiods.

The changes in the contributions of different sectors of the

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* *Equation used in calculating growth rates is as follows:*
$\ln y = \ln A + t \ln \beta + \epsilon$
where y *= dependent variable* t *= time* ϵ *= error term*
Then growth rate = exp (β) *−1 multiplied by 100.*

Iraqi economy to the gross domestic product during the period 1960-1978 have not been very significant (see table 2.2). In 1960 the relative shares of gross domestic product, as measured in 1969 constant prices, among the sectors were mining and quarrying 37.1 per cent, agriculture 17.3 per cent, services 16.9 per cent, distribution 14.3 per cent, manufacturing 9.6 per cent, and electricity, gas and water 0.64 per cent only. In 1967 the shares were changed to mining 28.2 per cent, services 20.7 per cent, agriculture 20.2 per cent, then distribution 17.4 per cent, manufacturing 8.7 per cent then construction and electricity, gas and water with 3.4 and 1.4 respectively. In 1972 the shares do not change much, the only changes over the year 1967 are, manufacturing shares increased to 10.6 per cent and agricultural share decreased to 18.3 per cent.

In 1978 the respective shares of mining and quarrying, services, distribution, manufacturing, construction were 28.9, 22.5, 19.0, 12.4 and 8.52 per cent, and agriculture declined sharply to 7.14 per cent. The most notable points are the sizeable increase in the share of construction sector and the high decline in the share of the agricultural sector during the last year.

In absolute terms, the sectoral GDP at constant factor cost in 1960 were : mining and quarrying 232.2, agriculture 108.36, services 105.9, distribution and manufacturing 60.18 millions of Iraqi Dinar*. In 1978 the corresponding sectoral GDP switched to mining and quarrying 827.5, agriculture 204.1, services 643.1, distribution

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* *Iraqi Dinar = 3.2 U.S Dollar.*

TABLE 2.2

Distribution of gross domestic product In Iraq, 1960-1978

(in millions of Iraqi Dinars)

sector	1960	1967	1972	1978
Agriculture	108.36	187.66	228.60	204.14
	(17.3)	(20.2)	(18.3)	(7.14)
Manufacturing	60.180	81.380	132.66	354.83
	(9.62)	(8.68)	(10.6)	(12.4)
Mining and	232.20	264.20	333.00	827.50
Quarrying	(37.1)	(28.2)	(26.4)	(28.9)
Electricity,	4.0074	13.510	13.700	41.489
Gas and Water	(0.64)	(1.44)	(1.01)	(1.45)
Construction	25.540	32.020	42.300	243.60
	(4.08)	(3.42)	(3.38)	(8.52)
Distribution	89.600	164.80	183.50	543.94
	(14.3)	(17.4)	(14.9)	(19.0)
Services	105.90	193.75	296.80	643.10
	(16.9)	(20.7)	(23.7)	(22.5)
GDP	625.74	937.34	1230.5	2858.6
	(100)	(100)	(100)	(100)

Notes:

1. Figures in parenthesis are percentage of respective sector in the total.
2. All figures are in 1969 constant prices.

Sources: see text.

543.9, manufacturing 354.8, construction 243.6 and electricity, gas, and water 41.5 million of Iraqi Dinar. While mining and quarrying, services, distribution, manufacturing, construction, and electricity, gas, and water increased by 3.6, 6.1, 6.1, 5.9, 10.4 times respectively, agriculture increased by only 1.9 times over the period 1960-1978.

A point to be mentioned here is the considerable increase in the utility, services and distribution sectors. This was facilitated by the increase of oil wealth.

To sum up, the Iraqi economy during the period under study was still an oil economy depending heavily on its oil revenue. Some changes started to be noticed such as the increasing trend of the manufacturing contribution as well as other commodity sectors, excluding agriculture.

In order to measure the relationships between the economy and its seven sectors, the simple correlation coefficient was calculated. This might help to explore the relative importance between them. The matrix shows, (see table 2.3), that the highest correlation among the economy and its sectors is with the distribution sector, followed by manufacturing then mining and quarrying. The lowest correlation is with the agricultural sector.

Among the different sectors the agricultural sector is less correlated to other sectors, than any other ones. The correlation

TABLE 2.3. Simple Correlation coefficient Matrix among the economy and its different sectors.

Economy	1.000							
Agricultural	0.742	1.000						
Manufacturing	0.981	0.429	1.000					
Mining and Quarrying	0.979	0.414	0.967	1.000				
Electricity, Gas, Water	0.949	0.589	0.984	0.926	1.000			
Construction	0.941	0.357	0.951	0.969	0.882	1.000		
Distribution	0.994	0.431	0.971	0.968	0.950	0.947	1.000	
Services	0.978	0.479	0.941	0.928	0.932	0.854	0.967	1.000

coefficient of mining with other sectors excluding the agricultural ranking from 0.926 with electricity, gas and water to 0.968 with the distribution.

However, most of the sectors are correlated to each other very closely reflecting the high relationships among the different sectors as well as the economy. The only exception is the agricultural sector.

2.4 POPULATION STRUCTURE.

Iraq's population has grown very fast at about 3.2 per cent per year. According to the result of the 1977 census its population was 12 million, increasing to over 15 million in 1988. The degree of urbanization is relatively high and increasing rapidly. In 1977, the portion had increased to over two-thirds of the total.

The distribution of a population among different age groups has always been important to the development of any country. If a large part of the population falls into ages 15-60, the working-age group, it indicates that the labour force is sufficient and can cooperate with other factors of development; while if the large part of population falls within the childhood or retirement, under 15 and over 60, then the country has insufficient labour force.

The working-age class portion representedin 1960 about 47.2 per cent of the total population. This means that 52.8 per cent of the total population is either under 15 or over 60 years of age. This portion increased to 52 per cent in the 1970's. With the emphasis on education, the youth will be entering to the labour force at later age as a result of spending a longer period in school. At the same time there is a considerable percentage of persons over the retirement age continue in private business or serve as a consultant. Accordingly the upper and lower boundaries might be reduced from one direction and expanded in other.

The literacy rate was very high; the number of people who do not have the ability to read and write estimated to be 2.3 million (Al-Baath, 1982). The highest proportion was in the age group 15-45 (69 per cent). In 1978 a national comprehensive campaign for compulsory literacy was issued. The aim of the campaign was to disseminate literacy to all the population between the ages of 15 and 45 within less than 2 years. As a result 76.4 per cent of these were liberated from their illiteracy within less than two years.

The growth in the level of education was permanent feature which it is clear from the increasing number of pupils and student. In 1978, number of student reached 2,459,870, while the number in 1960 was only 939,538.

The population growth, high education, womens attitude toward work, will naturally lead to demographic development which will consequently lead to a similar growth in the volume of labour force.

2.5 EMPLOYMENT STRUCTURE.

In the developing countries the shift of labour force from the traditional sector to the modern sectors can be taken as an indicator of economic growth. However, as table 2.4 indicates, employment opportunities have been created in almost all sectors during the period under study. In fact number of employees increased by 3.91 per cent overall the period – not as fast as the increase in GDP, given the dominant role of oil.

TABLE 2.4.

Distribution of employment by sectors, 1960-1978

thousands.

sector	1960	1967	1972	1978
Agriculture	733.90 (45.9)	1177.4 (53.5)	1469.1 (54.9)	941.1 (29.3)
Manufacturing	130.00 (8.13)	140.00 (6.36)	182.20 (6.81)	249.10 (7.78)
Mining and Quarrying	11.000 (0.69)	14.500 (0.66)	17.500 (0.65)	35.500 (1.11)
Electricity, Gas,and Water	11.800 (0.74)	12.400 (0.56)	14.600 (0.55)	26.100 (0.82)
Construction	58.000 (3.63)	59.100 (2.69)	69.200 (2.59)	185.60 (5.80)
Distribution	210.00 (13.1)	272.00 (12.4)	318.00 (11.9)	422.90 (13.2)
Services	245.00 (15.3)	285.00 (12.9)	320.00 (12.0)	1047.5 (32.7)
Others	200.00 (12.5)	240.20 (10.9)	285.40 (10.7)	294.30 (9.19)
Total	1599.7 (100.)	2200.6 (100.)	2676.0 (100.)	3202.1 (100.)

Note: Figures in parenthesis are percentages of the respective sectors.

Sources: see text.

The most striking fact shown in the table is that, although the mining and quarrying sector is the most important contributor to the gross domestic product (37.1 per cent in 1960 and 28.9 in 1978), it is practically the least important sector in employment, in the best case it contributes no more than 1.1 per cent of total employment. This sector is heavily capital-intensive. Furthermore, most of the labour employed in this sector is unskilled.

The sectoral shift of employment has not kept pace with that of sectoral value-added in the Iraqi economy, at least for the period up to 1972. The Agricultural sector has continued to count for the largest proportion of total employment among the seven sectors, but it lost its position to the services sector in 1978. However, in 1960 the highest shares were that of agriculture with 45.9 per cent, services, distribution, and manufacturing 15.3, 13.1 and 8.13 per cent respectively. In 1972 the agriculture share increased to 54.9 per cent while that of services, distribution and manufacturing declined. This might be the result of migration from urban to rural areas.

The picture changed dramatically in 1978. The agricultural sector lost almost half of its share in the total employment. The services share increased almost three times. Although the employment in all of other sectors increased more or less, but it seems that most of the shift of the agricultural employment went to the services sector.

However, Iraq has a limited supply of labour and its development to some extent depends on imported labour as most of the Gulf states. One important point in here is that most of imported labour force is from other Arab countries. Although there are no exact figures on the size of imported labour force it is estimated to be 1,808 in 1973, increasing to 2,523 in 1974.* Imported labour should in general enable the importer country to obtain higher skilled and trained personnel.

2.5.1 LABOUR PRODUCTIVITY.

Having considered the output and number of employees in each sector one might now proceed the analysis a little further based on the relative productivity among sectors.

Table 2.5 shows the estimated labour productivity on sectoral and aggregate levels, for selected years. Productivity in the mining and quarrying sector increased much more than other sectors, while the agricultural productivity lagged behind those of other sectors. In 1960 the lowest level of productivity were in the agricultural sector and the highest in mining, followed by manufacturing then services and distribution. The picture in 1967 did not differ very much from 1960 except the decline in the manufacturing productivity leaving its place to electricity, gas and water which came only behind the mining and quarrying sector, followed by the services sector. In 1972 the

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* *Those figures appears in the Annual Abstracts of Statistics 1975, 1974. The numbers of imported labours have increased sharply in the years following 1974.*

only change is the high increase in the productivity in the manufacturing sector. This resulted in changing position with the distribution sector.

After having calculated the productivity rates for the individual sectors as well as for the whole economy from the series of output and labourforce (see Appendices), they were then used to show the intersectorial disparity in the relative labour productivity between the Agricultural sector and the other sectors/economy.* The results obtained for both sets of calculations are displayed in table 2.5.

In 1960, the productivity in mining and quarrying is far higher in relation to that of agriculture, in fact more than 140 times that of agriculture. Manufacturing productivity was more than 3 times than that of agriculture, where as by comparison the service sector was slightly less than 3 times. The lowest was that of construction productivity with around one and half.

In 1967 the level of productivity of the electricity, gas and water sector was more than 6 times that of agriculture, while services, manufacturing, distribution, and construction were only 3 times that of agriculture. The level were much higher in 1978: electricity, gas and water more than 3 times, both manufacturing, and

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* *Often this measure is used to compare the level of development between nations. It is inversely related to development level, so that the advance countries suppose to be low relative to the values for developing countries (see Simon Kuznets, "economic growth of nations", Harverd university press, 1977, p 208, also see David G. Edens " Oil development in the Middle East", Praeger publisher, 1979, p153).*

construction more than 6 times, and distribution a little slightly less than 6 times. Only in mining and quarrying and services their relative levels were declined.

Our figures also show productivity in the agricultural sector lagging far behind the other sectors as well as the whole economy. This in fact is not only as a result of the slow increase in the productivity of the agricultural sector but a much faster increase in other sectors, especially the utility sector, manufacturing, construction and distribution which is reflected in the higher resource allocation to those sectors.

Productivity growth during the 1972-1978 subperiod was faster than that reached previously. This could be as a result of greater productivities in the Distribution, Construction and Manufacturing sectors.

From 1972 to 1978 the percentage growth rate of labour productivity of the various sectors were: agriculture 5.7, manufacturing 11.8, mining and quarrying 3.4, electricity, gas and water 9.2, construction 13.6, and distribution 14.3. The only decline was in the services sector. These compared to growth rates of 1 per cent in agriculture, 3.9 per cent in manufacturing, 13.2 per cent in construction, 4.9 per cent in distribution, 6.7 per cent in services and a declining rate of 2.1 per cent in mining and quarrying sector between 1960 and 1967.

The large differences in labour productivity among the different

TABLE 2.5.

Labour productivity by sectors in Iraq for selected years

Econ/Sector	1960	1967	1972	1978
Economy	391	426	460	893
Agriculture	148	159	156	217
Manufacturing	462	581	728	1424
Mining and Quarrying	21109	18222	19029	23311
Electricity, Gas, and water	340	1089	938	1590
Construction	227	542	611	1313
Distribution	427	599	577	1286
services	432	680	928	614

Intersectorial disparity in selected sectorial productivity

%

Econ/Sector	1960	1967	1972	1978
Agriculture	100	100	100	100
Manufacturing	312	365	467	656
Mining and quarrying	14263	11460	12198	10742
Electricity, Gas, & Water	230	685	601	733
Construction	153	341	392	605
Distribution	289	377	370	593
Services	292	428	595	283
Total	264	268	295	412

Sources: see text.

sectors must have played an important role in the allocation of labour force. This role should have a positive effect on the highly productive sector and a negative effect on the lagging sector, i.e. agriculture.

2.6. CAPITAL FORMATION AND ITS ROLE IN IRAQ'S GROWTH.

In every nation and in all times capital formation played a vital role in achieving high rates of economic growth and productivity. This role becomes even more influential in the case of a country with a limited supply of labour, and at the same time described as an unlimited supply of capital. Furthermore, not only the magnitude of capital formation on aggregate level is important, but so also is the distribution of capital formation among the different sectors. By doing so, one might make an abstraction about the different government strategies, and then evaluate them according to the growth rates of value-added originating in those sectors.

On the aggregate level table 2.6 shows the relative importance of capital formation compared with gross domestic product during the period 1960-1978. From the table it can be seen that:

1. The relative importance of capital formation to gross domestic product has seen a general decrease during the period 1960-1968. Two factors might be the reason for that decline; One, the political instability which had a direct effect on investment in the private sector. And, two, as a result of law number 80 of

TABLE 2.6.

Capital formation and gross domestic product and their relative growth rates, at 1969 constant prices, 1960-1978.

Year	GKF	growth rate of GKF	GDP	growth rate of GDP	relative importance
1960	130.9	-----	625.7	-----	20.9
1961	148.0	13.1	698.1	11.6	21.2
1962	133.1	-10.1	738.0	5.7	18.0
1963	119.7	-10.0	726.2	-1.6	16.5
1964	131.9	10.7	841.5	15.9	15.7
1965	140.4	6.5	956.1	13.6	14.7
1966	156.2	11.2	991.4	4.0	15.8
1967	147.2	-5.8	937.3	-5.7	15.7
1968	144.5	-1.8	1083.3	15.6	13.3
1969	157.2	8.8	1109.7	2.4	14.2
1970	179.5	14.2	1123.7	1.3	16.0
1971	183.7	2.3	1191.9	6.1	15.4
1972	204.7	11.4	1230.5	3.2	16.6
1973	268.0	30.9	1360.0	10.5	19.7
1974	368.2	37.4	1499.1	10.2	24.6
1975	570.7	55.0	1912.2	27.6	29.8
1976	634.4	11.1	2190.1	14.5	29.0
1977	575.4	-9.3	2451.2	11.9	23.5
1978	762.9	32.6	2858.6	16.6	26.7

Sources: tables A.5 and B.1.

1960, according to which 99.5 per cent of Iraq's territory was wrested from the grip of foreign oil companies. This law induced the foreign oil companies not to invest in Iraq.

2. From 1969 on the relative importance of gross capital formation to gross domestic product has increased, especially after 1974. It reached its highest during the year 1975, In fact around 30 per cent of gross domestic product went to investment. This surely imitates the ambition of the government to transfer the economy to modern one.

3. Capital formation played an important role in achieving the high growth rate of the overall economy during the period studied. However capital formation increased from 130.8 million of Iraqi Dinar in 1960 to 174.2 million in 1967, further, in 1972 gross capital formation increased to 204.7 million and to 762.9 million in 1978 (see table A.5 in appendix A).

Overall investment increased from about 14.7 per cent of total GNP during the 1960-1967 subperiod to 18.8 per cent during 1968-1972, and to 25.9 per cent during the 1973-1978. subperiod. The high investment will not only sustain the high growth rates achieved but it will give a greater opportunity to accomplish even higher rates in the future, especially most of the investment in the form of highly advanced technology transferred from abroad. Moreover, the existed infrastructure, as a result of heavy investment, will support the future modernization of the economy and further development of the commodity sectors

Capital formation on sectoral level (see table 2.7) will assist in making a better understanding of the different strategies adopted by different regimes.* furthermore, one may evaluate the performance of the sectoral investment by looking to the growth rates achieved in those sectors with high priority. It seems clear that the services sector has had priority during the different regimes: more than 30 per cent of total investment went to this sector. In fact this reflected the willingness of the government to raise the standard of living of people by increasing education, health, etc. Underlying this emphasis was the consciousness by authorities that professional and skilled manpower was anticipated to continue to be the most critical bottle-neck in the development programs (Abed and Kubursi, 1981).

The share of the distribution sector in gross capital formation was also high compared to other sectors, which is about 20 per cent. Most of the investment in this sector went into transportation, communication, development of airports which is important for future development.

After the services and distribution sectors the priority given

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* *During the period 1960-1978 four regimes have been taken over the government. First, Abdul Kareem Qassem from 1958-1963, Al-Baath party from February 1963-November 1963. Abdul salam Arief and his brother Abdul Rahman, from nov 1963- july 1968 . Finally from 1968 and on Al-Baath party.*

TABLE 2.7.

Distribution of capital formation by economic sectors in selected years, 1960-1978 (million of I.D.)

sector	1960	1967	1972	1978
Agriculture	13.7	16.5	29.6	68.6
	(10.5)	(11.2)	(14.5)	(9.00)
Manufacturing	10.4	35.4	47.6	109.
	(8.00)	(24.1)	(23.3)	(14.3)
Mining and quarrying	24.7	1.43	12.3	81.4
	(18.9)	(0.97)	(6.02)	(10.7)
Electricity, gas	8.50	13.1	10.8	69.2
and water	(6.49)	(8.89)	(4.97)	(9.07)
Construction	1.60	2.51	4.80	21.2
	(1.60)	(2.51)	(4.80)	(2.78)
Distribution	31.2	29.7	36.8	167.
	(23.8)	(20.2)	(18.8)	(21.9)
Services	40.7	48.6	63.4	246.
	(31.1)	(33.0)	(31.0)	(32.3)

Notes:

1. Figures in parenthesis are shares of relevant sector in the total.
2. All figuers are in 1969 constant prices.

Source: table A.5 in appendix A

to the manufacturing sector except in the year 1960 when the accumulation in the mining and quarrying sector exceeded the manufacturing sector.

The impact of high investment in the services and distribution sectors were limited. This is because investment is directed to physical and human infrastructure projects which has its affect over along period of time, even though, during the period 1973-1978 very high rates were achieved in those sectors, which are 22.1 in the distribution sector and 12.7 per cent in the services sector.

Investment among other factors in the manufacturing sector led to an increase in value-added of 8.6 and 23.6 per cent respectively in the subperiods 1968-72 and 1973-1978. Capital formation in the agricultural sector has had very little impact on the growth of value-added in this sector. In fact, while capital formation in this sector increased by 5 times, value-added increased by slightly less than two times. However investment in the agricultural sector does not pay off immediately since it went to projects with a long gestation period.

The high increase in government expenditure was not without its negative aspects, however, for it drove the economy to its ceiling production barriers, and caused increasing scarcity of skilled labour, a row material, housing and infrastructural facilities. As a consequence of this wages, prices and profits, and the misallocation of scarce resources would rise.(However, those factors normally associated with inflation.) But although inflation in Iraq continued to increase and some time into double figures,* "it still remained lower than in most oil producing countries" (Abdul-Rasool, 1982). This low rate of inflation is the result of the governmental control of prices through many instruments such as the large subsidies to major commodities, the domination of the public sector, and the existence of price regulatory system.

2.7 NATIONAL DEVELOPMENT PLANNING.

Although the planning experience in Iraq goes back to 1927 when the first development plan was introduced (Sayingh, 1977), and the first five years plan introduced in 1950 after the establishment of the development board, the first comprehensive framework of development took place after the 1958 revolution. However, during the period 1960-1970 there were two five-years plans. The first one covered the period 1961-1965, and this was replaced by a one year program after the revolution of 1963. There was another one year program by the political regime which had taken over after the 1963 revolution. A second plan was legislated in 1965 to cover the period 1965-1969. After the 1968 revolution special attention was paid to

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* *Consumer and wholesale prices, 1975-100.0*

	consumer prices	*wholesale prices*
1960	*58.7*	*63.4*
1965	*62.1*	*65.6*
1970	*73.8*	*75.2*
1975	*100.0*	*100.0*
1978	*128.8*	*125.0*

Source: IMF, "International financial statistics", yearbook 1984, pp 90-91.

national development planning without which "it would be impossible to build and develop the national economy in a harmonious and successful manner where each branch compliments the other. It would also be impossible, especially for the underdeveloped countries, which are characterized, in general, by their weak productive institutions to effect a comprehensive and harmonious development" (AL-Baath, 1974).

In the 1970s Iraq promulgated a five years plan for the period 1970-1974. The second plan covered the period 1976-1980. In between those two plans a 9-months "transition program" was launched.

Iraq in its development, particularly after the 1968 revolution, assigned high priority to the public sector as being the base of the socialist transformation (see progress under planning, 1975). In addition to the public sector there are private and joint sectors. However, the public sector through its investment is the most important one.*

The importance of the public sector comes from not only insuring the independency of the investment planning from pressures of private investors but also to build up a public infrastructure that would encourage the private and joint investment. In fact the relative importance of investment made by public sector to the total

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* *For an exposition of some of the key elements of the socialist philosophy of the Al-Baath party see the political report of the eigth national congress (1974), and see also the central reports of the nineth national congress (1982) of Al-Baath party.*

investment increased from 43.1 per cent in 1960 to 55.5 per cent in 1967 and to 84.0 per cent in 1978 (see progress under planning, 1975).

At this stage it would be useful to review the main features of the national development plans published during the period 1959-1980.

I. The Provisional Economic Plan 1959-1962.

This plan was luanched after the 1958 revolution. It was far more ambitious than all the preceeding ones . The main feature of the plan was that the share of oil revenue in financing the plan was reduced from 70 per cent to 50 per cent. This would make the plan less independent on the policies of the foreign oil companies. One other feature of this plan was the launch of the Iraqi-Soviet economic agreement. According to this agreement the Soviet Union helped to implement several industrial projects. Another important event is the legislation of the Agrarian reform (Law number 30 of 1959). According to that reform maximum limits for agricultural ownership were defined.

Data on total allocation and expenditure under this plan are shown in table 2.8.

As can be seen from the table, in addition to the fact that the amounts allocated to the industrial and agricultural sectors were low compared to the amount allocated to other sectors such as housing, transportation and communication, the amount actually spent was very low compared to the total amount allocated. In fact total expenditure

TABLE 2.8. Total allocation and expenditure under the professional plan, 1959-1962. (millions of Iraqi Dinars).

Sector	Allocation		Expenditure	
	Amount	Percentage	Amount	Percentage
Agriculture	47.9	14.8	23.1	21.2
Industry	48.7	15.0	13.7	12.6
Transportation & communication	100.8	31.1	23.3	21.3
Housing	76.4	23.6	48.9 (Housing and Public building combined)	44.9 (Housing and Public building combined)
Public building	50.5	15.5		
Total	324.4	100.0	109.0	100.0

Sources: Allocation figures from Jawad Hashim, The planning experience, table 1, p 267, Ministry of Planning (1970). Expenditure from Statistical Pocket book (1972), table 91, p191, Ministry of Planning.

in percentage was as low as 12 per cent in the industry. This reflects the low level of experience , as well as the low absorptive capacity of this sector. The only exception is public building and housing where they spent 44.9 per cent of the sources allocated.

II. The Detailed Economic Plan, 1961-1965.

This plan became effective from 18-12-1961. For the first time the goals and the aimed rates of growth were set. More attention was given to the industrial sector, which had been neglected in the previous plans. In fact 30 per cent of total amount allocated devoted to the industrial sector. It placed a relatively increased emphasis on agriculture, and this was reflected in the allocation funds which

TABLE 2.9.

Total allocation and expenditure under the detailed economic plan, 1961-1965. (millions of Iraqi Dinars).

Sector	Allocation		Expenditure	
	Amount	Percentage	Amount	Percentage
Agriculture	113.0	20.3	19.9	10.0
Industry	166.8	30.0	38.3	19.1
Transportation & Communication	136.4	24.5	55.0	27.5
Building & Housing	140.1	25.2	87.0	43.4
Total	556.3	100.0	200.2	100.0

Sources: Allocation figures are from Jawad, Hashim, "the experience planning, table 66, p 205, Ministry of planning (1970). Expenditure from Statistical Pocket book (1972) table 91, p 191, Ministry of Planning

amounted to 556.3 millions of Iraqi Dinars, as shown in table 2.9.

As in the previous plan the amount actually spent was low, although in total the percentage spent was higher than that of the preceeding one.

The sources of financing the plan came mainly from oil revenue, with 76 per cent of the oil revenue being devoted to this plan. The rest came from the profit of public owned enterprises with 4.1 per cent and from external loans with 13.9 per cent. The chief goals of the plan were:

Achieving an annual rate of growth in the national income of 10 per cent.

Diversification of the economy in order to reduce the dependency on the oil revenue.

Using the oil revenue more efficiently.

Increasing productivity of different economic sectors.

Elimination of feudalism and reforming land distribution.

Expansion of the government services i.e, education, health, etc.

By February 1963 the plan was replaced by a one year development program as a result of the 1963 revolution. The terms of funds allocation under this program shows in table 2.10.

TABLE 2.10 Total allocation and actual expenditure under the 1963 development program (millions of Iraqi Dinars).

Sector	Allocation		Expenditure	
	Amount	Percentage	Amount	Percentage
Agriculture	22.8	19.3	4.5	8.3
Industry	39.6	33.5	9.5	17.5
Building & Housing	25.4	21.5	21.2	39.1
Transportation & communication	29.8	25.2	18.3	33.8
Other	0.7	0.5	0.7	1.3
Total	118.3	100.0	59.3	100.0

Sources: Allocation figures are taken from Jawad, Hashim, "the planning experience", table 1, p 267. Expenditure extracted from Statistical pocket book (1972), table 90, p 191, Ministry of Planning.

The main feature of this plan was the showing of private expenditure on development along with that of public expenditure. It estimated the private investment to be 43 per cent of total amount allocated. Financing this plan was from oil revenue and private expenditure.

In November 1963 another political regime had taken over the power and late in 1964 a five year plan was legislated. In 1964 the new regime had announced the nationalization of all major industries.*

III. The New Five Year Economic Plan, 1965-1969.

The plan was put in action in 1965. The sectoral pattern of funds allocation is presented in table 2.11. Total amount allocated by this plan was 631.8 million of Iraqi Dinars. The plan intended the following average annual growth rates:

- Annual rate of growth of 8 per cent in national income.
- Annual rate of growth of 7.5 per cent in agricultural sector.
- Annual rate of growth of 12 per cent in industrial sector.

In addition to accomlishing the above rates of growth the plan aimed to:

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* *The nationalization include, 4 cement industries, 3 milling companies, 2 shows companies, 3 cigarette companies, 3 trading companies, 2 spinning and weaving companies, cotton, seed, jute, carpets, building materials, papers, maches, vegetable oil, banks and insurance companies.*

1. Speeding industralization and diversification of the economy.
2. Improving the agricultural productivity.
3. Developing alternative exporting goods so as to become less dependent on the oil revenue.
4. expanding of education and health services.
5. Increasing electricity supply.

TABLE 2.11.

Total allocation and actual expenditure under the new five year plan, 1965-1969 (millions of Iraqi Dinars).

Sector	Allocation		Expenditure	
	Amount	Percentage	Amount	Percentage
Agriculture	146.5	23.2	56.3	15.7
Industry	175.0	27.7	103.9	28.9
Transportation & communication	103.8	16.4	61.2	17.3
Building & Services	113.8	18.0	66.3	18.5
Other	92.6	14.7	71.4	19.9
Total	631.7	100.0	359.0	100.0

Sources: Allocation figures are taken from Annual Abstract of statistics 1980, table 6/2, p 140. ministry of Planning. Expenditure extracted from Statistical pocket book (1972), table 93, p 192, Ministry of Planning.

A certain feature with this plan was the high share devoted to the industrial, followed by agriculture sectors. More than 50 per cent of the total amount allocated under this plan was spent. This was high compared to the percentages of total expenditure under the previous plans.

IV. The National Development Plan, 1970-1974.

This plan is the first one legislated and implemented by a government under the leadership of the Al-Baath Party. The planners had designed this plan with two major principles in mind: first, the concentration and integration in the productive projects on the regional and national level in such a way as to ensure the attainment of their final stages and realization of their returns as soon as possible. And second, the extension of public services.

The plan was put in action in 1970 with a total allocation of 1143.7 million Iraqi Dinar. A year later the total allocation had increased by 788.3 million. Allocations were distributed among different sectors as shown in table 2.12. The main objects of the plan are:

1. A growth rate of 7.1 per cent in the national income, 6.9 per cent in agriculture, 12 per cent in industry, 8.2 per cent in distribution, and 6.0 per cent in services sectors to be achieved.

2. An improvement of the standard of living, especially of the lower income groups.

3. Providing the production prerequisites for all productive units.

With regard to the allocation of funds, industry recieved about 20 per cent, followed by 18.9 per cent for agriculture. After those sectors the priority was given to physical and social infrastructure. In the event, actual expenditures in the commodity sectors turned out to be close or even higher to total allocations.

In the period 1970-1974 real gross domestic product in factor cost increased at an average annual rate of 7.5 per cent. In the case of industry (including manufacturing, mining, electricity, gas and

TABLE 2.12.
Total allocation and actual expenditure under national development plan, 1970-1974 (millions of Iraqi Dinars).

Sector	Allocation		Expenditure	
	Amount	Percentage	Amount	Percentage
Agriculture	366.2	18.9	208.2	17.8
Industry	391.0	20.2	327.4	28.0
Transportation & Communication	222.2	11.5	176.9	15.1
Building & Services	283.0	14.7	169.2	14.5
Loans granted to department & organizations	105.0	5.4	132.2	11.3
International obligations	54.5	2.8	47.7	4.1
Other investment expenditure	495.3	25.6	100.6	8.6
Total	1932.0	100.0	1169.8	100.0

Source: Allocation and Expenditure extracted from Statistical Pocket Book, 1978, Ministry of Planning, p 105-109.

water, and construction), the actual growth rates fell short of the planned target - 7.8 versus 12 per cent in the plan. Growth rate in the agricultural sector fell far short of the target rate of 6.9 per cent not only because of institutional impediments but also because of technical difficulties related to the build-up of salinity in the soil. Actual rate of growth in the services sector slightly exceeded that of the plan target (6.3 aginst 6.0). Similarly, the destribution sector increased at an average annual rate of 8.6 percent and thereby exceeded the target rate of 8.2 per cent.

The implementation of this plan has caused a severe shortage of building materials. One final note about this plan is that it is directed toward Arab economic integration.

V. Transition Program, 1975.

After the national development plan of 1970-1974, the government decided to luanch a 9-months investment program which covered the period 1st of April to 31st of December 975. There were two major reasons, among many, behind this program: First to unify the dates of the investment program, general budget, and importation program on the first of January of every year. And second, the aim of achieving a kind of coordination in the field of planning with most of the Arab countries.

The total amount allocated by this program is extremely high compared to previous plans (more than 90 per cent of the whole

TABLE 2.13. Total allocation and actual expenditure under the 1975 development programs (millions of Iraqi Dinars).

Sector	Allocation		Expenditure	
	Amount	Percentage	Amount	Percentage
Agriculture	207.5	19.3	99.9	10.9
Industry	448.0	41.6	290.2	31.7
Building & Services	166.0	15.4	138.0	15.1
Transportation & communication	188.0	17.5	101.1	11.0
Planning, follow-up statistic & special fund bodies	6.3	0.6	2.3	0.2
Loans of government establishment & agencies	9.6	0.9	12.6	1.4
International loans	8.6	0.8	7.9	0.9
Other investment expenditure	42.0	3.9	26.4	28.8
Total	1076.0	100.0	916.3	100.0

Source: Allocation and Expenditure extracted from Statistical Pocket Book, 1978, Ministry of Planning, p 110.

allocation of the period 1961-1969). With regard to the allocation of these resources, industry had the first priority, followed by agriculture, and the building and services (see table 2.13). The allocation follows not only the importance of such sectors in the economic development but the possibilities for implementation.

The program was financed mainly by oil revenue, 65 per cent of the program financed by oil, 23 per cent by foreign loans, and the remainder from other sources.

The main feature of this program includes a strategic return's projects and the inclusion of projects treating the bottle-necks facing the 1970-1974 development plan. With regard to the agricultural projects included in this program, most of them are related to irrigation and draining projects or related to agricultural services. In the industrial sector the program emphasises chemical industry projects, (which is correctly introduced *), metal and construction industry projects.

VI. The National Development Plan, 1976-1980.

Having accumulated some planning experience in the previous years, the government lead by the Al-Baath Party enjoyed great political stability as well as the advantages of oil price increase and so a new five years plan was formulated.

The amount allocated under this plan was higher than ever,(14993.1 million I.D) most of it for the commodity sectors, - it exceeded those of all previous national development plans by 6 times.

The main objects of this plan were:

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* *Iraq as well as most of the oil exporting countries having a comparative advantage in many basic industries, mainly Petrochemical and primary metals, their production cost are the lowest in the world, energy-intensive industries.*

1. Attainment of the following annual growth rates:

   A. 16.8 per cent in the national income.

   B. 15.5 per cent in the mining and quarrying sector.

   C. 32.9 per cent in the industrial sector.

   D. 16.9 per cent in the distribution sector.

   E. 10.4 per cent in the services sector.

2. Increasing agricultural sector productivity and introducing high advanced technology in the production process.
3. Increasing industrial sector productivity by improving the labour force skills, optimum geographical distribution of industrial settlement, and integrating the industrial plans with agriculture.
4. Improving public services.
5. Urging the national saving.
6. Urging the public sector.
7. Improving the infrastructure.
8. Concentrating on projects with the ability to increase value-added.
9. Priority was given to the electricity sector in an effort to support industralisation as well as for electrifying the rural areas.
10. Modern industrial projects with highly advanced technology.

Three years after launching this plan the actual growth rates achieved on both sectoral and aggregate levels were impressive compared with the relatively high rates set as plan targets. In the period 1976-1978, on aggregate level Iraq has managed to achieved a

TABLE 2.14.

Total allocation under the national development plan, 1976-1980 (millions of Iraqi Dinars).

Sector	Allocation	
	Amount	percentage
Agriculture	2162.9	15.0
Industry	4489.5	30.0
Building & services	3140.2	21.0
Transportation & communication	2318.1	15.0
Other allocation expenditure	2882.4	19.0
Total	14993.1	100.0

Note:

Figures on actual expenditure are not available.

Source: Law # 89 of 1977.

growth rate of 14.2 per cent compared to 16.8 per cent in the plan target. Growth rate of the industrial sector (including manufacturing, electricity, gas and water, construction), during the first three years of the plan was more than 14 per cent , this compares to 32.9 per cent to be reached over the entire period of the plan. The services sector already exceeded its target rate. In the distribution sector the achieved growth rate was almost equal to the target one. Thus one can say without too much hesitation that the economic plans in the 1970,s have achieved some success in creating a more diversified economic structure.

2.8 ROLE OF FOREIGN TRADE

International trade has always played a strategic role in shaping the Iraqi economy. Further, its importance substantially increased as a result of a rapid increase in the quantity of exports, or an improvement in exports prices. However, Iraq's exports depend mainly on oil export. The percentage comparison of the value of non-oil export to that of export clearly exhibit the dominance of petroleum in the Iraqi economy (see table 2.15). from 1960 to 1978 the variation in the percentage of oil exports to total exports was never less than 90 per cent.

Exports increased sharply during the period 1960-1978 (around 13 times between 1960-1978); imports increased 10 times, and subsequently, the export surplus amounted to I.D 1793 million in 1978.

For Iraq as oil exporting country it is not difficult to imagine that it has faced difficulties due to the internal factors operating on the supply side, but also to external factors affecting the demand side.

Imports in Iraq consist of a wide range of commodities, mainly machinery and equipment and capital goods. Food imports have accounted for 21.2 per cent of all imports in 1960, 16.1 per cent in 1967, then dropped to 11.2 per cent in 1978. Imports of machinery and equipment have increased from 9.9 per cent in 1960 to 14.0 in 1967 and to 55 per cent in 1978 of the total, reflecting Iraqi's increased

Table 2.15

Iraqi foreign trade for the period 1960-1978

year	total export	oil export	2/1	total import	balance
1960	233.6	222.6	95.3	138.9	95.7
1961	236.3	223.1	94.4	145.7	77.4
1962	247.2	223.7	90.5	128.8	94.9
1963	278.8	259.0	92.9	114.0	145.0
1964	299.9	281.8	94.0	147.4	134.4
1965	315.0	293.6	93.2	162.6	152.2
1966	333.6	308.9	92.6	176.1	157.5
1967	293.6	272.0	92.6	151.2	142.4
1968	371.0	345.0	93.0	144.5	226.5
1969	373.3	347.4	93.1	157.2	216.1
1970	392.4	367.6	93.7	181.7	210.7
1071	549.4	526.2	95.8	247.9	301.5
1972	440.6	421.5	95.7	234.7	205.9
1973	706.7	677.4	95.9	270.3	436.9
1974	2420.9	2325.7	96.1	773.4	1647.5
1975	2450.9	2414.6	98.5	1426.9	1024.0
1976	2737.9	2691.4	98.3	1150.9	1587.o
1977	2850.0	2807.3	98.5	1323.2	1526.8
1978	3266.6	3204.4	98.1	1473.6	1793.0

Note:

All figures are in million of I.D and at current prices.

Sources:

Figures on exports are taken from IMF,"International Financial Statistics", yearbooks 1967, 1975, 1976, 1980, and 1986. While those on Import from Annual Abstract of Statistics 1980, table 8/1, p 163, Ministry of Planning.

base of development.

To sum up, Iraq has no problem with its balance of payments and accordingly has no problem with financing its investment. In fact its problem is in its limited ability to absorb the total amount allocated to investment in the period under consideration (Al-Eyed, 1979).

As a source of import no single country has occupied a prominent position in Iraqi trade. However Japan stands as the greatest single exporter to Iraq in 1978. Its share increased from 4.7 per cent in 1960 to 20.9 per cent in 1978. The second place is occupied by Federal Republic of Germany with a share of 11.3 per cent. The place of the U.K in imports has declined from 34.1 per cent in 1960 to 6.2 per cent in 1978, while that of the U.S.A has declined but it still holds a sizeable share.

It seems that there has been a major structural change in the composition of Iraq's foreign trade, with regard to the high increase in imports, especially during the last subperiod. Also the fundamental change in the import composition. The share of capital goods has increased as a result of increasing domestic production. The structure of the geographical distribution of imports has changed as well. The share of U.K has declined while that of Japan increased. On the other hand, Iraq's export is still dominated by a single good, i.e., oil, and this is increasing in importance as a result of the high increase in price.

CHAPTER THREE

TECHNOLOGY TRANSFER, TECHNICAL CHANGE : CONCEPTS AND DEFINITIONS

3.1 INTRODUCTION

In recent years there has been increasing concern about technology transfer and technical change. Despite the fact that each topic individually as a subject has attracted wide attention, there nevertheless is a definite interrelationship between the two.

Since there are enormously wide interpretations and definitions as to the terms of technology transfer and technical change the two basic concepts will be individually discussed. Section 3.2 discusses the term technology transfer. The discussion can be separated into five major topics. The first, is on the different concepts and definitions of transfer of technology. The second shows the various channels of transfer of technology. The third investigates the nessesary conditions for successful transfer of technology. The fourth discusses the cost of transfer of technology. And the fifth outlines the adaptation of technology transferred from abroad to domestic climate.

Section 3.3 discusses the term technical change. This discussion covers the assorted types of technical change which occur in the third world and the different classifications of technical change. Finally, in section 3.4 the interrelationship between technology transfer and technical change is examined.

3.2 TECHNOLOGY TRANSFER

Technology transfer has long been recognized as an indispensable source of growth.* Evidence confirms the importance played by the transfer of technology in prehistoric societies; this importance has vastly accelerated since the middle of the last century as a result of the industrial revolution in Great Britain (Rosenberg, 1982). The direction of the transfer has frequently changed, many countries now belonging to the exporters of technology while they were importers a few centuries ago and vice versa.

Recently there has been much concern about the widening technological gap between developed and developing countries with and how to find a possible way to diminish this gap. Technology transfer plays an important role as "the counterpart of the technological gap" (Spencer, 1970). In spite of this importance some argue, (Amine, 1973) that technology transfer must lead to technological and economic dependency.†

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* *For an extensive review of the literature on transfer of technology see Sagafi-Nejaqd, Tagi and Robert Belfield, "Transnational corporations, Technology Transfer and Development: A Bibliographic sourcebook", Pergamon press, 1980: and Cheng, Leonard,"International Trade and Technology: A Brief survey of the recent literature", Weltwirtshftliches Archive, vol 120, 1984, pp 165-189.*

† *Technological dependency means that the economy has to import machines and inputs, and consequently has to stimulate exports,(especially of primary goods), to generate the necessary foreign exchange. As indicators to the dependency, the following indicators, inter alia, are used: (1) the percentage share of R & D in gross national product, (2) The number of scientists and engineers that are actually engaged in R & D. (3) Capital goods imported as a percentage of gross fixed capital formation (UNCTAD, 1978_a).*

In general the dependency exists if modern technology is used without generating learning effects and socially appropriate technologies, and the dependency on foreign suppliers will be increased. This should not be confused with inter-technological dependency. The latter means that although a country might be using technology produced somewhere else, at the same time it still has adequate know how to produce these goods on its own (for example Japan).

However, in spite of the view of the dependency school, it has now been admitted by most of the authorities in the third world that the capability to develop, adopt, and exploit technological knowledge is an exceptionally important feature. To achieve a nation's objectives, whether those objectives are economic development, international power and prestige, or economic independence, tecnhnology transfer has a vital role to play. Thus, national policy for technology transfer, and issues associated with the movement of technological information between different countries, have become important concerns for all countries regardless of their stage of development.

3.2.1 TECHNOLOGY, TECHNOLOGY TRANSFER CONCEPTS AND DEFINITIONS.

Both technology and its transfer are often interpreted in a wide sense. In spite of the extensive studies in this area technology is often confused with another concept, i.e. science. Where science is concerned with the increase of knowledge and understanding, technology is directed towards its application. Whereas the result of scientific research is usually the publication of a paper, the output of technological activity is a product, process, technique, or material developed for some specific use (Gee, 1974).

Technology is defined in different ways; according to Rosenberg (1972), technology is "man's capacity to control and to manipulate the natural environment in the fulfilment of human goals, and to make the environment more responsive to human needs", and Kuznets (1972) defines technology as " knowledge relevant to man's capacity to control the natural environment for the production of economic goods that enter final product in national economic accounting." Stewart (1979), defined technology as "knowledge of how to do and make useful things."

According to the UNCTAD (1972_a), technology is the indispensable input to production and as such it is bought and sold in the world market as a "commodity" embodied in one of the following forms:

1. In the form of capital goods and sometimes intermediary goods which are bought and sold in markets, particularly in connection with investment decisions;
2. In the form of human labour usually skilled and sometimes highly skilled and specialized manpower, with the capacity to make correct use of equipment and techniques;
3. In the form of information, whether of a technical or of commercial nature, which is either readily available in the

market or subject to proprietary rights and sold under restrictive conditions.

Moreover, the following components of technology are suggested by the UNCTAD.

1. Feasibility studies, market surveys and other reinvestment services;
2. Determination of the range of technologies and the choices of technology;
3. Industrial processes;
4. Engineering design and detailed engineering;
5. Plant construction and installation;
6. Training of technical and managerial personnel;
7. Management and operation of production facilities;
8. Marketing information;
9. Improvements to processes and product designs.

Since technology includes a wide range of elements and uses for different purposes, it is classified in many different ways by many different authors. Mansfield (1975) distinguishes between *general technology* - information common to an industry or trade, *system-specific technology* - information concerning the manufacture of a certain item or product that any manufacturer of the item or product would obtain, and *firm-specific technology* - information that is specific to a particular firm's experience and activities, but that cannot be attributed to any specific item the firm produces.

Farrel (1979) distinguishes between consumption technology and production technology, where production technology refers to methods, processes etc. for production of goods and services, and consumption technology refers to methods, processes and techniques by which particular need or demand may be satisfied.

Some even go further in distinguishing between transfer of high technology and transfer of low technology, where high technology refers to a sophisticated range of products such as automative equipment, transportation, electronic computers, etc. The main characteristics of this type of technology are: Enormous expenditure on research and development, a sizeable element of complex patented or non-patented technology, fast and continuing technological change, and high capital investment (Barson, 1985).

Another specification which will be useful for our purpose is classifying technology as: 1. Hardware or the process to make things. This takes the forms of factories, machines, products or infrastructures. Further, it must be visible. 2. Software technology. which includes such inmaterial things as knowledge, know-how, experience, education and organization forms.

It can be seen from the above definitions that the main feature of most definitions is that they highlight one or some special aspect of technology, such as its subject, method and type, whether it takes a material or non-material form, as well as its legal and systemic characteristics.

For the purpose of this study technology refers to "an aggregate of skills, techniques, and knowledge, which enables man to utilize the existing resources efficiently for desired goals." *

In view of the above definitions of technology one can now choose an accepted definition for its transfer-like technology itself there is still no clear consensus on its definition. Some important distinctions should be made from other concepts with which technology transfer is sometimes confused. First, it is important to distinguish between vertical and horizontal technology transfer. Vertical transfer refers to the transmission of innovation into production, so that, it "occurs when information is transmitted from basic research to applied research, from applied research to development, and from development to production" (Mansfield, 1975). On the other hand horizontal transfer of technology "occurs when technology used in one place, organization and context is transferred and used in another place, organization context" (Mansfield, 1975).

Second, it is important to distinguish between planned and unplanned transfer of technology. Planned transfer of technology refers to that kind of transfer which aims to diminish the technological gap between developed and developing countries. In other words, it "refers to the modern systematic acquisition and purposeful use of foreign developed technology for promoting

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* *This definition by John Jeseph Murphy"Retrospect and prospect" in The transfer of technology to developing countries, edited by Daniel.L. Spencer., and Alexander Woroniak, New York: Fredrick.A. Pragers, pp 6-7, 1967.*

technological change and economic development" (Spencer, 1970). On the other hand unplanned transfer of technology is that kind of transfer which "just happened", and it is a slow process "like the ooze of liquid seepage" (Spencer, 1970).

Having distinguished between planned and unplanned, horizontal and vertical transfer of technology, we now turn to define transfer of technology. The concept of transfer of technology, as that of technology is difficult to pin down. However, the confussion about the definition of the transfer of technology might be caused, partly by the imprecise nature of technology itself, and partly because transfer of technology involves two parties, the transferor and the transferee. At mean time on which item should be included and which should not.

However, technology transfer according to Graham (1982) is defined "*as* the reciept and utilization in one nation of technology developed in some other nations." Brook (1968) defined it as "processes by which science and technology are diffused through hummane activity. Thus wherever systematic rational knowledge is developed by one group or institution and is embodied in a way of doing things by other institutions or groups we have technology transfer." In Fransman (1985) it is refered to essentially as "the process whereby knowledge relating to the transformation of inputs into outputs is acquired by entities within a country from sources outside the country." For the purpose of this study we are defining technology transfer as it is defined by Fransman (1985), since it is concerned mainly with the transfer of production processes from one nation to another.

3.2.2 CHANNELS OF TECHNOLOGY TRANSFER.

There are many channels through which technology can flow from transferor to transferee. This might be the result of defining technology very broadly to include knowledge about infrastructure and services, agriculture as well as industry. Consequently, there are many methods in categorizing the various channels used for transferring technology.*

Regardless of the bases according to which the categorization is

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* *Hansion (1975), categorises them according to their effects on the Balance of Payments. So that, there are two types of technology transfer "non-negotiable" or "non-commercial" and "negotiable" or " commercial".*
The non commercial transfers include:
1. *The monitoring of foreign technical journals.*
2. *The once-off purchase of individual products which are then used and perhaps copied.*
3. *Some industrial espionage.*

While the commercial transfers include:
1. *Large-scale machinery and other purchases.*
2. *Purchases of licences and know-how.*
3. *Cooperation agreements.*
4. *Direct foreign investment.*

For Spencer (1970) those channels might be classified according to the bodies involved in the transfer transaction. Thus those channels are:
1. *Government to government, there is also the United Nation and related agiences effort, such as the world bank which can treated as an international bodies.*
2. *Business channels, which from the mean by which most of the complicated technologies are transferred. This channel included licensing and Know-how agreements.*
3. *Direct investment.*

footnote continued overleaf

made, two facts remain true. The first one is that the less the transferee is developed in terms of technological and managerial sophistication the more 'packing' the transfer is likely to take. this is because the country may not have sufficient capacity to put the package together itself, and because it may not have a strong bargaining power to insist on doing so (Stewart, 1979). The second fact is the different channels of transfer are not mutually exclusive, and for example a particular industrial project may require the use of all or most of these diverse methods of transmission in order to effect the successful incorporation of productive instruments and ideas into the project.

However, according to Stewart (1979) technology might be transferred formally and informally. Informal transfer might take place through the flow of books, journals and other scientific and technical publications, contact between people, and through the movement of trained people between countries, while formal transfer might take place through direct and indirect channels.

continued footnote

4. *Person to person example reading of technical and scientific journals and reports. It is not costly and sometimes free.*
5. *Universities, this channel include the students from overseas to study in developed to developing countries.*

Or they might be classified according to the degree of ownership (see Dehlman and Westphal, 1982).

3.2.2.1 INDIRECT CHANNELS OF TECHNOLOGY TRANSFER

Those channels include:

I. Direct Foreign Investment.

(nowadays predominantly in the form of the so called Multinational Corporation). This channel is the oldest way by which technology is transferred. One of the most important features of this channel of transfer is its attempts to ensure full control of the foreign investor, involving creations of subsidiary by the parent firm in recipient country. The major features of direct foreign investment are identified as follows:

> Apart from the accompanying technological flow in the form of production technology, marketing skills, managerial expertise, etc., the major features of direct foreign investment are that (1) it involves a flow of capital from one country to another, (2) it presents entry into a national industry by a firm established in foreign market, and (3) it entails operational control by the investing firm over decision-making by the local firm. All these basic features are intertwined and flow from one another. Unless the foreign firm processes a unique advantage in the form of a monopoly over some specific asset, usually technology, there would be little reason for it to move abroad. In the absence of such an advantage local firms can effectively compete with the foreign firms (Balasubramanyam, 1973).

There is a debate as to the usefulness of direct foreign investment for the recipient country, and although there are those who claim that direct foreign investment is to be seen as an agent of development, there are also those who wish to condemn it as a weapon of exploitation; both would agree however, that it has now become an extremely powerful agent of technology transfer (OECD, 1974).

The size of investment, as an indicator of the importance of this channel, can be identified. Altogether direct foreign investment for firms in all countries totalled to about $350 billion in 1982, of which about 60 per cent was undertaken by U.S. firms and 10 per cent by British firms. Foreign investments by German and Japanese firms were small until the 1970s, when they began to increase rapidly. From 1973 to 1978 the value of U.S. direct investment abroad increased by two-thirds (Aliber, 1983).

The motives for the direct foreign investment as stated by Aliber (1983) are: First, foreign firms competing abroad are usually at a disadvantage in relation to their home country competitors. Second, some firms find that it is more profitable to provide through a local rather than a distant home. Third, firms invest abroad when further expansion within their traditional industries in the domestic market becomes difficult or expensive. One reason might be that demand for their products is growing more slowly, perhaps because the domestic market is saturated. In this situation, the firm might expand into other industries in the domestic market - that is, they might cross borders between industries. Alternatively, they might cross national boarders, expanding abroad with their traditional products. For many firms, crossing national borders may be easier than crossing industry borders, given their expertise in producing or marketing particular products.

Another motive which can be added to the above is that foreign firms attempt to take advantage of the local labour force with their low wages and raw materials with their low prices (Manser and Simon, 1979).

Direct foreign investment is often preferred to licence agreement despite the risk involved. Baranson (1970) has given a number of reasons which can lead the foreign investor to choose one or other means of technology transfer. According to him large firms prefer direct foreign investment to licensing agreements in branches of industry with a high density of research, in order to control the evaluation of the market for their products, and thus to avoid competition for know-how and to protect standardization and the brand name of their products, and also to avoid customs barriers in many developing countries who have adopted import substitution polices.

There are objections to this direct foreign investment raised by developing countries. Those objections are mostly viewed in political terms. According to Manser and Simon (1979) and Lamers (1976)* these objections are:

1. Charging high prices for materials supplied from the parent firms and underpricing of products sent from the subsidiary to the parent.

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* *The first three points are from Manser, the two points which follow are from Lamers.*

2. The ability and willingness of these companies to transfer their production facilities elsewhere if greater advantages present themselves in other countries.

3. Developing countries often object to the stream of profit to the parent in excess of incoming capital and thus generating new categories of imports in the form of material for production.

4. Technology transfer by this channel was transferred without adaptation to the factor endowment in the host countries, so that they would result in increasing rather than decreasing unemployment. One should point out here that recently, in an attempt to remedy this situation, some legislation has been passed.* which included certain general invocations requiring foreign investors to employ local people "where available", "if qualified" or "as far as reasonably practicable" leaving the judgement to the foreign invester (Zakariya, 1982).

5. It resulted in stifling local entrepreneurship.

In spite of the objections listed above there are some advantages to the direct foreign investment (Lamers, 1976), those are:

1. Introduction of managerial skill.
2. Transfer of technology and know-how.
3. Training of local labour force, and creating new employment opportunities

* *An example for such contract is the EGPC/ESSO(EXXON) contract of 1974 in Egypt.*

4. Generation of additional tax revenue.

5. Productivity spill-over.

6. Transfer of capital.

As a result of the different interests between host countries and foreign investor there is often conflict between them. The possible sources of conflict as stated by the OECD (1974) are: First, the fact that those firms which are "private" have the urge to make profits. Second, that it is the "large and oligopolistic" ones which have the overwhelming strength. Third, that they are "foreign" in terms of the focus of ownership and controls, and furthermore that they are "foreign" too in terms of the origin of their technology, their products, know-how, use of materials, management practices, which have all been re-adapted to the foreign environment.

Another point worth mentioning in this context is the mean age of technology transferred through this channel to subsidiaries located in the developed and developing countries, and the difference of that mean age in comparison with other channels such as licensing or joint ventures. According to a study by Mansfield and Romeo (1979), which included 65 multinational firms who have their headquarters in the U.S, there are substantial differences (see table 3.1). As the table shows, the mean age of technology transferred to overseas subsidiaries in developed countries is 5.8 years, which is far less than that of technology transferred to developing countries. On the other hand, the table shows that the mean age of technology transferred via licensing or joint ventures is significantly higher than that transferred to subsidiaries overseas, this confirms the attitude of multinational firms in not selling their newest technologies.

TABLE 3.1
Mean and standard deviation of number of years between technologies transferred overseas and first use in the United States. For 65 technologies.

Channels of technology transfer	mean years	Standard deviation years	Number of cases
Overseas subsidiary in developed country	5.8	5.5	27
Overseas subsidiary in developing country	9.8	8.4	12
Licensing or joint venture	13.1	13.4	26

Sources: Edwin Mansfield and Anthony Romeo. "technology transfer to overseas subsidiaries by U.S. based firms", Research paper, University of Pensylvania, 1979.

With regard to the Iraqi experience with this channel of transfer of technology foreign direct investment was operated in the Iraqi oil industry up to 1972. In fact Iraq could not exploit this channel of technology transfer efficiently because of the deliberate action of the foreign oil companies in not expanding the technological base in Iraq and thus prevent it from being able to axploit its resources on its own. In fact after more than half a century, during which direct foreign investment was via multinational corporations operating in the country, Iraq only had a limited technological base. Consequently the Iraqi National Oil Company (INOC) made a separate agreement with the French Oil Company, ERAP, (I'Enterprise de Recherchés et d'Activities Pétrolieres) to explore some 10,800 square Kilometres of the North Rumaila field in the south of the country in 1967. It was thought that the experience which it gained throught this and other petroleum activities would give INOC some confidence to nationalize the Iraqi Petroleum Company (IPC) in 1972.

II. Joint Ventures.

This is an alternative to direct foreign investment. In the late 1970's it became clear that joint ventures had changed position with the concept of wholly owned foreign subsidiaries and thus became far more important as a channel of transfering technology through direct foreign investment (Baranson, 1978). A joint venture according to Tomlinson (1970) is defined broadly as "one where there is the commitment, for more than a short duration, of funds, facilities, and series by two or more legally separate interests to an enterprise for their mutual benefit".

These two enterprises might be government or individuals. Most of the developing countries attempt to have a higher share than that of the foreign enterprise in order to guarantee a control on the joint venture.* This is so since the higher share by the foreign enterprise always induces them to behave in the same way as of the direct

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* *Many big companies do not accept participation in joint ventures, General Motors, for example, insist on the complete or single ownership principle of its overseas subsidiaries and do not accept a sharing control. Their argument is based on their policy which states* "in a unitary way a company can meet competion and change in the world economy, as well as deal effectively with local nationalism" *(Spencer, 1970).*

foreign investment.

Technology transferred through this channel could be either capital or labour intensive, depending on origin. Recently, by the involvement of the Japanese into this business they offer a small scale joint venture, labour intensive, where a minority ownership is accepted. (Ozawa, 1985).

Joint venture is the best way to overcome the conflicts which often arise between the foreign investor and the host country. However, it has its own merits and demerits, according to Lamers (1976) these merits to the host country are:

1. Introducing managerial skill.
2. Transferring know-how and advanced technology.
3. Training of local labour force.
4. It is a good way for solving the potential conflict which often arises between host country and foreign investor.
5. The foreign investor cannot subordinate the joint venture's interest to those of the foreign enterprise.
6. It offers a chance to the domestic investors to establish a large project which it would be difficult to undertake on its own because of insufficient resources and know-how.
7. The foreign partner can help by his exporting experience to export the surplus of the production to the foreign markets.

III License Agreements.

This provides a vehicle for "renting" disembodied technology and know-how by the owner's country or organization to other countries lacking this technical knowledge, for specified royalties and technical fees. There are three types of such agreements, these are: patent right, know-how right and trade mark right (Raffin, 1974). On an international level, payment for patent and know-how reached $ 11 billion in 1982 and increased by 2 percent per year between 1975 and 1983 (Vickery, 1986). This reflects the importance of this channel in transfering technology.

License agreements are often preferd to direct foreign investment as a means of technology transfer when a foreign firm wants to avoid the risk of setting up subsidiaries in the host country. According to Baranson (1970), licensing agreements are preferred in the following cases:

The market is too small to warrant investment or the product cycle proprietary position is ephemeral.

The firm has marketable technology, but lacks the resources or experience for direct investment.

Direct investment is precluded by legal constraints or seems to involve high risk of a political or economic nature.

Reciprocal benefits are obtainable through cross-licensing, and patent legislation or competitive technological development may be avoided.

According to the usual licensing agreements there are obligations on both the licensor and the licensee. The licensor's major obligations are: First, to grant license rights with respect to owned or controlled patents, trade mark and/or know-how. And second, to supply information, technical components, and/or services of various kinds. While the licensee's major obligations are to pay specified royalties and other fees and to exploit the license rights and know-how as contracted (Raffin, 1974).

In addition to the two obligations stated above there are often other implausible obligations, such as, the limitation of the markets the licensee can export to (UNCTAD, (1972_a). If the license is without export restriction, the fees paid may be far higher (Guertin, 1977), or the restrictions placed on the purchasing of raw materials and parts from specified suppliers.

However, in spite of the restrictions often imposed on the licensee, license agreements have proved to be an important vehicle for the transfer of technology as the explosive success of Japan in recent years has shown (Cetron, 1974 and Ozawa, 1966)). As far as the Indian experience is concerned, the licensing agreement has been the favoured means of acquiring technologies not available locally (Lall, 1985). The success of those countries is a result of their ability to absorb and effectively utilize the technology transferred to them.

IV. Turn-key Contracts

This channel involves transfering technology as a complete package, which includes furnishings of technical and managerial operations required to operate the plant for a specified period of time. Accordingly, permitting the recipient to make a product similar to that produced by the original producer, as intended in practice (Baranson, 1985).

Most of the turn key agreements took place during the primary stage of development as a result of a lack of the local skills.

In recent days, there is much concern on transferring "highly packaged" technology. The reasons for this are:

1. the "highly packaged" transfer of technology gives the suppliers a monopolistic position. Consequently, they will be able to impose higher prices comparatively with unpackaged transfer. This is not only because of costs for different elements of the technology are difficult to determine and to negotiate separately, but because "the required compliance at every stage of implementation to a predetermined set of guarantees satisfying the conditions for payment by the recipient induces the supplier to cover his costs as early as possible, thus minimizing the financial losses if the recipient is not fully satisfied and retains payment" (UNCTAD, 1978_a).

2. Turn-key transfer has an implicit tendency to perpetuate further

technological dependence of the host country on the specific foreign supplier, or at least on a number of other foreign suppliers.

3. The experience and confidence which might be gained in the process of "learning by doing" will be minimized as a result of the little use made of local technical skill and management in implementing and operating projects (UNCTAD, 1972_a).

With regard to the Iraqi experience, turn-key contracts as a means of transfer of technology have been explored in depth in the hope that this would accelerate growth of economy, despite the problems involved with this kind of transfer. However, this is not an unfamiliar strategy in the early stage of development, but over the long-run a greater degree of attention should be given to increasing the nation's share in the global technology mix, and thus avoiding repetitive imports of technology (UNCTAD, 1978_b)

3.2.2.2 DIRECT CHANNELS.

In addition to those channels we have just mentioned there is the direct method of transfer of technology. According to this type of transfer an agreement is made between either the owner of technology or the main supplier of machinery, or often a consulting organization, and the recipient country or entrepreneur.

Technology transferred by this channel according to Siggel (1983) involves the following forms:

1. Direct contracting of foreign personnel and consultant companies.
2. Training of local personnel.
3. Transmission of know-how concerning the project and its run, product design, management technique, design of production process and facilities etc.
4. Design acquisition of productive equipment.

Contracting foreign personnel will help in overcoming the problem almost always faced by all the developing countries, i.e. the shortage of skilled manpower. The availability of skilled manpower is necessary for exploiting to the fullest extent the potential advantages of imported technology. Training of local personnel might be done through the enrolment in the vocational schools or by sending them abroad.

The know-how is usually available from its suppliers for agreed prices, or by hiring managers or technicians or by getting a certain document in which the know-how is embodied.

3.2.3 CONDITIONS FOR TECHNOLOGY TRANSFER.

In order to get the greater advantage from technology transferred through the channels mentioned in the previous section certain conditions should be met. Some of these can be associated directly with certain channels of transfer, others are more general and apply to the process itself. Among the most important conditions are the following:

1. Willingness of both the transferor and of transferee.

Developing countries in general are willing to transfer developed technology as long as this technology:

(a) Is suited to the factor endowment of that country. Most of the developing countries have unemployment problems, so that labour intensive technology is the technology the developing countries are most willing to transfer.

(b) Generates a significant learning effect.

(c) Involves the transfer of the marketing rights.

Moreover, the decision by developing countries will be affected by some other factors such as cost, or other alternatives, politics, dependency etc.(Stewart, 1979).

On the other hand, the transferor is willing to transfer his technology for the following reasons (Spencer, 1970):

(a) On the economic level, the firm in a developed country is looking for profits and other business advantages, such as potential competition. In some cases the low wages or cheap raw materials in a developing country might attract a firm in a developed country to offer its technology through a joint venture, licence, or direct investment.

(b) On the political level, the advanced country has the assurance that it is not losing contact with developing countries.

(c) On the socio-economic level, the developed country likes to avoid isolation which builds up other modern people with like-minded interests.

2. Research and Development.

Another important condition which should be satisfied by the host country for a successful transfer of technology is a minimum expenditure on research and development. It is argued that research and development expenditure is like an investment, so that, one has a choice between investing in machines and investing in R & D (Stiglitz, 1987).

As far as developing countries are concerned, we should distinguish between "absorptive R & D" and "creative R & D". By the former we mean that kind of research and development directed to the adaption of foreign technology to the domestic environment. The latter type of R & D is directed towards domestically originated inventions (Blumenthal, 1979). However, most of the research and development in the developing countries is of the "absorptive" type, rather than the "creative" type.

Research and development in the developing countries is important for the following reasons; First, to improve their economic performance by using the imported technologies effectively. Second to adapt the imported technologies which are often not entirely appropriate with respect to local consumer's tastes, market size, factor prices, etc. Third, to help in building up an indigenous technological capability which will enable them to reduce their future dependence on imported technologies and perhaps even to become independent in technology (Katrak, 1985). And fourth, to provide material, social, and moral incentives to attract research professionals to remain in their countries and to entice back those that emigrated to other countries (Goulet, 1977).

Using the Japanese experience as an example of a successful transfer of technology, this shows that the import of foreign technology was not isolated from, but was in fact parallel to the efforts of domestic R & D. According to Oshima (1974) a survey of 1500 companies which imported foreign technologies during the period 1955-66 showed that 83 percent of those companies were already involved in some R & D related to the technology imported, and 31 percent were already carrying on some related development work

As far as Iraq's efforts on research and development are concerned it spent between I.D 0.15 and 0.21 million in 1966 increased to ID 7.4 million in 1974 and to ID 27.0 million in 1976.* This means that Iraq's expenditure on R & D formed 0.25 and 0.65 percent of its gross national product in the years 1966 and 1976

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* *Figures for the years 1966 and 1976 are from Zahlan 1984, while those for the year 1974 are from* Pfetsch 1975.

respectively.*

The most important organization concerned with research and development in Iraq is the Foundation of Scientific Research established in 1980. This foundation constitutes various centres which deal with advanced technology. There are currently seven scientific journals in publication by this foundation in order to promote scientific research, one of its most important objects is to orientate research toward applications and adaptation of transferred technology (Ath-Thawra International, Oct.21, 1988).

The distribution of the expenditure on R & D might be of great interest since it gives an idea about whether this expenditure is in important areas or not. In fact, data of this kind is very rare. The only detailed study is that of Pfetsch (1975) which shows the pattern of the expenditure on R & D in the year 1974. His figures show (see table A.6 in appendix A) that expenditure on research on agriculture, forestry and fishing accounted for 46.6 percent of the total, followed by " general advancement of knowledge" for 33.8 percent. In the mean time only 8.6 percent was spent on research and promotion of industrial development. Based on the above figures, and bearing in mind that most of imported technology is of the industrial type, one can say that technological research was not directed to the most important areas during the period studied.

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* *Although the percentages seems small in fact Iraqi's expenditure was higher by far than most of the Arab countries.*

The number of engineers, which is always taken as another indicator to the scientific and technological base of any country, increased sharply during the period under consideration. In fact this number increased from 3.6 person per 100,000 person in 1966 to 14.1 person per 100,000 person in 1974 (Zahlan, 1984).

3. Suitable educational system.

The importance of the existence of an appropriate educational system in the host country has long been recognized. In the nineteenth and the early twentieth centuries it was found that the countries to gain most from the transfer of technology were those that had an appropriate educational system (Rosenberg, 1982), that an effective education system would provide the required technicians, engineers, and management etc.

In Iraq great effort has been made in order to improve the scientific and technological base. In 1972 the Foundation of Technical Institutes was established in order to provide middle level technicians. The number of students has been increasing sharply, from 2,085 students in the academic year 1972-1973 to 12,242 in 1977-1978. Three years later the University of Technology was established in order to provide the required engineers. Number of students in this university was around 5,000 in 1975-1976 increase to more than 67,000 in 1977-1978.

The number of students in the Iraqi universities is, like that of the Foundation of Scientific Institutes and the University of

Technology, increasing overtime very rapidly, in fact, the figure increased from 12,260 in 1960-1961 to 35,261 in 1967-1968 and to 50,376 in 1978-1979.* Although the number of students is important, the distribution of those students among the different fields is rather more important. Data shows that during the year 1974-75 only one-fifth of the student enroled in the universities went into the engineering fields, and 14 percent in to natural sciences. The remainder were in the social sciences and humanities (UNCTAD, 1978_b). This distribution does not seem to reflect the imperative requirements of the country in term of professional personnel in the technological field.

A higher ratio of students in higher education should go to the engineering and natural sciences fields if the increasing demand for high quality technical personnel is to be met.

4. Appropriate institutions and management systems.

Another condition essential to advocate national technological advance is the existence of appropriate institutions and management systems, the latter being important for understanding the application of technology. While the appropriate institution is necessary for,

(1) Organizing the collection and distribution of needed information

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* *Figures extracted from different issues of Annual Abstract of Statistics.*

and on that basis to develop and carry out proper policies for imported technology.

(2) Evaluating the transfer policies in order to accomplish maximum benefits from the transfer of technology, and

(3) Executing the negotiation with the transferor (UNCTAD, 1972_a).

In addition to the conditions mentioned above there are many others, such as a sufficient market size, adequate financial resources, a suitable government especially when the main of transfer is foreign investment rather than domestic investment.

3.2.4. COSTS OF TECHNOLOGY TRANSFER.

The market for technology is an imperfect one because first, sellers have the right to not sell their product (Chudson, 1977). Second, the price of technology is higher than their marginal cost, and third its price is not definitely determined, so that they are subject to bargaining strategy and games theory (OECD, 1974), particularly when technology becomes associated with direct foreign investment as the case of the oil industry (UNCTAD, 1978_a).

In fact the existing evidence shows that the price of technology sold to the developing countries (in form of roylties fees, purchases of machinery, etc.) has been undoubtedly high (UNECLA, 1969). Thus in order to stimulate the transfer of technology to developing countries their cost has to be reduced sharply (Thomas, 1974).

Developing countries have argued that technology is part of the universal heritage of mankind and thus it has the character of public goods. Accordingly all countries have a right of access to technology for increasing their social welfare. However, this point of view is countered by the fact that in many developed countries (such as United States which is the largest supplier of technology) governments are prevented by constitutional restraints from confiscating private property (Tecee, 1977).

The cost of technology transferred to developing countries varies according to the channels by which that transfer has occured, the degree of packing, as well as the number of applications. For multinational firms there is a high cost of transfer, at least for production of initial units, but transfer cost will decline once the first production run has begun. For channels other than multinational firms, i.e. joint venture or licensing, the cost is determined according to the transferers experience, size, research and development (Shahal, 1981). With regard to the degree of packing evidence shows that, the more packaged the technology transfer, the higher the cost (Stewart, 1979).

In general costs incurred by technology importing countries, according to UNCTAD (1972_b) are direct and indirect costs and they can be classified as the following:

1. Direct Cost.

These costs refer to that kinds of payments for the transfer specifically stated in the contract between the supplier and the recipient.

This payment includes charges for:

(a) The right to use patent, licences, know-how and trade marks, in other words payments for roylties and licence fees. Payments for roylties are regularly the largest and paid as a percentage of total sale or gross value of production. In some cases the supplier asks for participation instead of the above payments.

(b) Technical knowledge and know-how required both in the pre-investment and in the investment stages and in the operation stage, i.e. payments paid for foreign consultants. This type of cost in both enterprise as well as government level would increase as the importer inadequate a relative information about other suppliers and consequently he is not going to purchase from the lowest case supplier (Katrak, 1985).

2. Indirect Cost.

These costs, unlike direct costs are not necessarily specified in the contract, they fall into different ways and are often associated with restrictive practices. However, they include the following components:

(a) Overpricing of intermediate input and equipment, which normally have to be purchased from the supplier of technology. Overpricing mostly is due to the fact that the recipient of the technology has weak negotiating power as compared to the supplier, whether the reason for this is lack of information or because of monopolistic power of the supplier. Nevertheless, the difference between the price paid to the supplier and the price on a free market is an "indirect cost" incured by the recipient of the technology (Thebaud, 1977).

(b) Profits on capitalization of know-how in the pattern of shares in the receiving company.

(c) Some portion of the profit of a fully foreign owned subsidiary, or joint ventures which have no special provision to pay for the transferred technologies from the price.

(d) Imports of capital and other technical equipment, the price of which usually allows for the supplier valuation of the cost of technology.

3. Other Indirect Costs

In addition to the two types of costs, i.e. direct and indirect, there are "hidden costs" which impose implicit cost on technology recipient countries. Some of those restrictions are shown in table 3.2.

According to the classification of cost described above Iraqi payments on imported machinery, equipment and other capital goods, according to a study by UNCTAD (1978_a), was I.D 22.7 million in 1965, rising to I.D 727.1 million in the year 1975; this is equivalent to 18 percent of Iraq's gross domestic product. As a result of overpricing Iraq is paying two or three times that normally paid in free markets for raw and intermediates materials. Consequently, cost amounted to I.D 72 million or 1.8 percent of the country's gross domestic product in the 1975. This undoubtedly, was higher than the average paid by developing countries.* In making a rough estimate of the total cost incured by Iraq, in addition to the direct cost, (which is only a small part of the total) we should add the indirect cost. Unfortunately, data of this kind is not available.

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* *Studies by the UNCTAD covering Hungary, Chile, Ethiopia, and Spain show that on the average those countries are paying around 0.33 percent of their GDP as a direct cost for the imported technology (UNCTAD, 1978a).*

TABLE 3.2.
Pattern of limitations on access to technology by developing countries

Type of limitation imposed by suppliers	Replies to whether the host country faced the specific limitation	
	Yes	No
1. Tied purchase of imported inputs, equipment and spare parts	Argentina, Chile, Iran Ecuador, Malta, Peru Mexico,Nigeria,Pakistan Srilanka,Turkey,Cyprus.	Korea
2. Restriction of exports (total production,partial limitation, geographical constraint)	Argentina, Chile,Cybrus Ecuadore,Greece, Turkey Iran,Malta,Mexico,Perru Nigeria, Pakistan, Srilanka.	
3. Requirement of guarantees against changes in , taxes tariffs and exchange rates affecting profits, royalties and remittances	Cyprus,Nigeria,Turkey	Greece,Iran, Malta,Mexico Singapore
4. Limitation of competing by:		
a) restriction of competing imports	Cyprus,Nigeria,Turkey	Iran,Mexico Malta,Turkey Pakistan Korea Singapore
b) preventing competition for local resources	Creece,Malta,Mexico	Iran,Korea Singapore Nigeria Pakistan
c) obtaining local patent to eliminate competitor	Ecuador,Malta,Nigeria	Greece,Iran Singapore
5. Constraints limiting the dynamic effects of transfer		
a) excessive use of expert personnel	Argentina,Malta,Mexico, Nigeria,Peru,Turkey	Singapore
b) discouragement of the development of local technical and resources and development capabilities	Argentina,Ecuador,Malta Mexico,Nigeria,Turkey	--------

Source, UNCTAD "*Major issues arising from the transfer of technology to developing countries*", Document no. TD/B/AC.11/10/Rev.1

3.2.5 ADAPTATION OF TECHNOLOGY TRANSFER.

The most striking fact about technology is that it is not neutral, but is influenced very much by custom, climate, availability of resources etc. In fact existing technology has been planned by and for the advanced countries to fit their factors of production and their available resources. Thus, technology imported by developing countries has to be adapted and according to Rosenberg (1982)

> the successful transfer of technology is not a matter of transferring a piece of hard- ware from one geographic location to another. It often involves much more subtle issues of selection and discrimination, and a capacity to adapt and modify *before* the technology can function effectively in the new socioeconomic environment

Previous experiences of successful transferees, Russia and Japan for example, during the first half of this century show that their successes are related mainly to their ability to adapt the imported technology (Stewart, 1978).

Between developed and developing countries, there are many differences which result in different levels of development. Consequently, technology appropriate* to the former might be not appropriate to the latter and thus there in a great need to adapt modern technology to the physical, social and economic environment of developing countries (Strassman, 1968).

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* *Appropriate technology refers to wide range of technologies characterized by any one or several of the following features: Low investment cost per work-place, low capital investment per unit of output, organizational simplicity, High adaptability to particular social or environmental conditions for employment prospects (Jequier, 1983).*

To what degree the adaptation of technology is necessary depends on the "suitability gap". The wider the gap the greater degree of adaption is required (Singer, 1977). In fact in many less developed countries the appropriate technology is the one which can be used for production of "basic products". In this case the adaption has to be greater since technologies in the advanced countries are designed to produce high standard goods, and it was found that motorycles, or motorbikes may be more appropriate than Automobiles for some developing countries (Cetron, 1977).

However, not all of the available technologies can be easily adapted to suit the needs of the developing countries without loss of efficiency. Examples of such technology are cement and petrochemical plants. In some cases there is no room for adaption, for example highly-yielding seed varieties originally developed in a specific soil, temperature etc. are not transferable since it is impossible to grow in a different environment (Bruton, 1977). The same can be said of "high technology" (OECD, 1974).

The ability of the recipient country to adapt is dependent upon the relevant research and development, in the adaptive R & D, and the availability of manpower required for carrying out the adaption such as engineering technicians, professional people, etc. The more sophisticated the technology, the greater the need for technological resources for effective adaption and use (stewart, 1981).

Furthermore, as far as the Chinise experience is concerned , it has been asserted that the effective stock of engineering design skill can to some extent substitute, thus avoiding conventional Research and development, machinery of laboratories, pilot plants, etc. Accordingly "It has been recommended that relatively more emphasis should be given to design skills and less to conventional Research and Development" (Singer, 1977).

With regard to the country under study i.e Iraq, before answering the question to what extent adaption is necessary and in what direction should be oriented, the following questions should be answered:-

1 - What is the abundant factor of production?

2 - What is the pattern of consumption?

3 - What is the size of the market?

By answering these questions we can then answer the question about adaption . In fact Iraqi development is characterized by a limited supply of labour and, as an oil exporting country , a healthy financial situation enabling it to import highly advanced technologies. Its pattern of consumption by no means differs from that of developed countries. With regard to the market size Iraq is a medium sized country and has an access to the Arabian market since it is a member of the Arabian Commune Market. It can be said that Iraq is eligible to make full use of technology transfer to it and it could be more succesful than many other countries with no need for a substantial adaptation.

3.3 Technical Change

The definition of technical change has involved a great deal of confusion. Much of the confusion seems to result from the fact that technical change means different things to different people.

However, technical change to (Solow, 1957) means "any kind of shift in the production function. Thus speed ups, improvements in the education of the labour force, and all sorts of things will appear as 'technical change'." To Abramovitz (1956) it refers to share of output not attributed to the conventional input, viz labour and capital. And he has called it measure of our ignorance.

To Denison (1962) it refers to research, economies of scale, improved methods, organizational and managerial ability. Further he called it total factor productivity rather than technical change. To Schmookler (1952) technical change means a device to satisfy wants better than does pre-existing knowledge and he has called it efficiency index. To Domar (1961) technical change is a Residual. It absorbs, like a sponge, all increases in output not accounted for by the growth of explicitly recognized inputs.

For the sake of clarity technical change can be defined to mean the improvement in the quality of inputs.* The above definitions have their advantages since they focus attention on the transformation of input into output.

However, according to the above definition of technical change,

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* *This definition is the same the one adopted by Fransman (1985).*

there are two types of impact of technical change, they are:

(a) More output can be produced by the same given quantities of the inputs (or, equivalently, the same amount of output can be generated by smaller quantities of one or more of input);or

(b) Existing output undergoes quantitative improvement. In most of the quantitative studies the second type of impact does not appear, this is because the improvement would only be shown as high prices, which are always treated as inflation and hence to be eliminated from the measure of output (Grilliches, 1979).

3.3.1 TYPES OF TECHNICAL CHANGE OCCURING IN THE 3rd WORLD.

According to Fransman (1985) there are five types of technical change which occurred in the 3rd world and here is a brief description of them:

<u>1 - The search for new products and processes.</u>

Although this kind of search is costly but it is important for the affiliates in the third world, whether they are firms or countries, to own the necessary technological capabilities. However, in order for these affiliates to gain additional knowledge they must have a minimum amount of knowledge. Search may include informal activities such as scanning of journals reading books attending seminars etc.

2 - The adaption of products and processes to local conditions.

As previously stated, technology is not neutral; it is designed for specific needs and to suit a certain factor endowment. So that, technology transferred from developed countries will need an adaption to some extent to be used as efficiently as possible. In the third world most of the adaptation is oriented to match the size and characteristics of local markets, the availability of skilled labour, the degree of competition in protected markets, and the availability and quality of local resources.

3 - Improving products and processes.

What is meant by this type of change are those activities which go beyond adapting the production and sale of products and processes to domestic conditions and involve their improvement in different ways. These improvements may be major or minor ones, nevertheless the cummulative importance of major improvements over time may be great.

4 - Developing new products and processes .

This kind of changes are very rare in the sense of unknown product by the world. However, what is meant by new product and processes are that kind embodied technical change in it. furthermore it is important to distinguish between new product and processes from the point of view of the firm, the industry, the country, and the world.

5 - Basic research.

Although there is very little basic research activity going on in the third world, such activity does exist. However, there is a question about the justification of such activities and the potential of the outcome of those researches.

In order to clarify the differences between those activities, there is a qualitative distinction between (a) searching for and using a machine; (b) repairing a machine (c) imitating and adapting a machine for domestic production and sale; (d) introducing an improvement on the machine; (e) designing and developing a new machine ; (f) basic research on the underlying principles that can be applied in the creation of machinery.

However, the activities such as (e) and (f) are rarely found in the third world as a result of their limited technological capacity and their dependency on the advanced countries in their technology.

3.3.2 CLASSIFICATION OF TECHNICAL CHANGE.

In the literature on technical change the three classifications of technological change most commonly used are those due to Hicks (1932), to Harrod (1948) and to Solow (1962). These types can be illustrated in term of two inputs (labour and capital) production function as the following:

In the Hicks sense, neutral technical change is the type of technology which does not alter the two input. In other words, the ratio of marginal productivity of labour and capital (Marginal Rate of substitution) does not change, in spite of the change in technology. Given a constant capital-labour ratio, so that Hicks neutrality is concerned with the effect of technical change during a short-run situation when both input factors would be available in a fixed amount.

Non-neutral technical change on the other hand, can be defined by the sign of the proportionate rate of change in the marginal rate of factor substitution for a given factor ratio. Thus it changes the relationships between the input factors and this would result in a change in the marginal productivity of the inputs.

Harrod's definition is concerned with analysing a long-run situation in which the supplies of input factors are not fixed, and required a constant capital-output ratio. Thus, technical change is Harrod-neutral if for a given capital-labour ratio, the marginal product of capital is kept constant, otherwise it is a biased one.

Finally, the Solow definition is consistent with an underdeveloped economy where the wage rate is very low and can not be lowered, since wage is at its subsistence level and at the same time it is not allowed to be raised since the market for labour has an unlimited supply curve. However, Solow neutrality occurs if , for a given output-labour ratio, the marginal product of labour does not change with a change in technology. And any change in the technology which resulted in a change in the marginal product of labour would be considered as a non-neutral technical change.

Symbolically the above three definition can be written as:

$$\left[\frac{\partial (F_K K)/(F_L L)}{\partial t}\right]_{\substack{K/L \\ constant}} \gtreqless 0$$

Hicks $\begin{Bmatrix} \text{Labour-saving} \\ \text{neutral} \\ \text{Capital-saving} \end{Bmatrix}$

$$\left[\frac{\partial (F_K K)/(F_L L)}{\partial t}\right]_{\substack{K/Q \\ constant}} \gtreqless 0$$

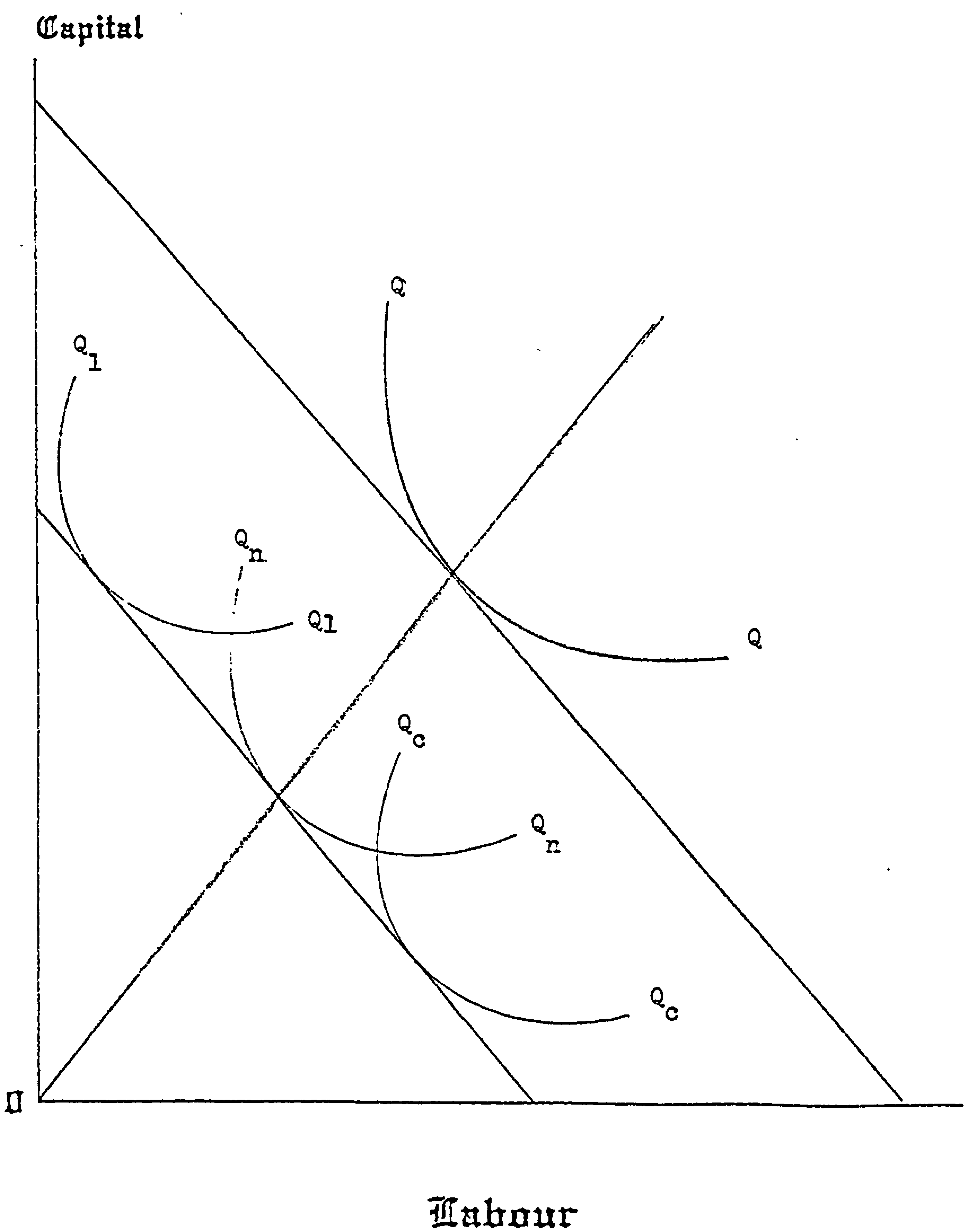
Harrod $\begin{Bmatrix} \text{Labour-saving} \\ \text{Neutral} \\ \text{Capital-saving} \end{Bmatrix}$

$$\left[\frac{\partial (F_K K)/(F_L L)}{\partial t}\right]_{\substack{L/Q \\ constant}} \gtreqless 0$$

Solow $\begin{bmatrix} \text{Labour-saving} \\ \text{Neutral} \\ \text{Capital-saving} \end{bmatrix}$

The production function can be represented graphically by means of series of isoquants, each of which corresponds to the constant output level which could be obtained by infinitely different combinations of capital and labour. In figure 3.1 a level of output QQ needed a relatively high level of inputs, but as a result of more advanced

Fig 3.1 An Illustration of Alternative Types of Technical Change



technology the isoquant had shifted toward the origin, so that the same amount of output could now be produced by using smaller quantities of inputs. However, under certain circumstances the resulting shift in the isoquant from technical progress might not change its slope. This is shown by parallelled shift of the isoquant (e.g. from QQ to Q_nQ_n). This situation occurred because technical change does not affect the relative marginal productivity of the input factors. This is called neutral technical change.

In some cases the shift of the isoquant toward the origin can take a number of paths. Thus the original isoquant could move to Q_1Q_1 reflecting a labour saving technical change as a result of raising the marginal productivity of capital relative to that of labour, or the original isoquant QQ could move to Q_cQ_c showing a capital saving technical change.

Another way of classifying technical change which will be mentioned often is to describe embodied and disembodied technical change. The embodiment concept emerges as a result of an attempt to restore the key role of investment to economic growth and development., after dismissing this role and assigning them to technical change. However the major argument backing the embodiment concept is that technical change takes place through improvements that are embodied in new capital equipment, and the newest capital good embodies the latest technology. Based on this the new addition to the capital stock must be weighted more heavily than earlier additions, which has the effect of increasing the sensitivity of growth to change in capital stock. This is in contrast to the disembodiment argument that all technical change consists of better methods and organization that improve the efficiency of both old capital and new.

If technical change viewed as capital-embodied rather than disembodied, somewhat different methods must be used to estimate the rate of technical change. One of the earliest attempts is that of Solow (1960) in his vintage model. Solow assumed that capital of different vintages, i.e. capital produced at different dates, embodied different technology, Solow explicitly incorporated the concept of embodied technology into an aggregate production function and assumed that embodied technical change took place at a constant exponential rate.

3.4 INTERRELATIONSHIP BETWEEN TECHNOLOGY TRANSFER AND TECHNICAL CHANGE

In the world economy as a whole there are strategies existing in context of technical innovation.* These are producing them domestically or borrowing them from their original innovators. So that, any particular country has the option of inducing research and development and producing its own innovations or, importing them embodied in one or other form of technology depending on the

* *We use the term of technological innovation and technical change to mean the same thing for ease of understanding.*

available channels as well as its financial situation, among other factors. The latter strategy seems to be the only logical choice for the developing countries in their early stage of development. However, although this will give those countries the opportunity of enjoying being a Late comer they should think not of re-importing the technology needed rather than producing it domestically.

In the next page we present the above two options available for the developing countries in form of flowchart. It shows that technological change is a result of domestic effort as well as through transfer of technology. However, the decision of which option to be used depends on government policies.

With regard to developing countries just starting their development, or still in their early stages, the domestic production of innovation is almost impossible or it is very costly. Thus the most effective way for them in their effort to improve their technological and scientific bases is by taking full advantage from the transfer of technology. Moreover, it is clear from the flowchart that technology transfer depends on the available channels as well as the required conditions for successful transfer.

From the above it becomes clear that technology transfer would lead to the creation of technological change. Combing those changes with the other tangible input factors will determine the economic development and social welfare of a nation

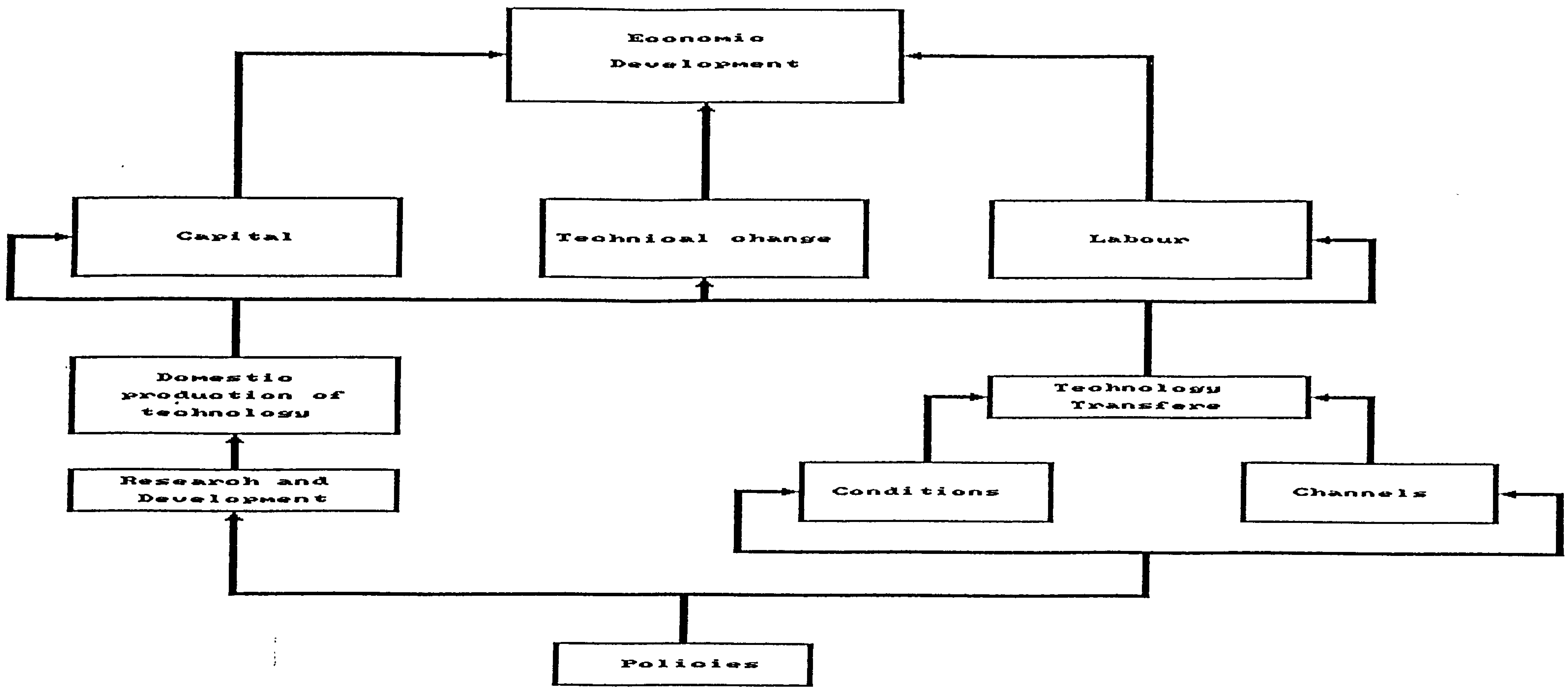


Figure 3.2 Alternative Technological Options For Developing Countries.

CHAPTER 4

REVIEW OF THE LITERATURE

4.1 INTRODUCTION

Exploring the role played by technology and its change has been an area of great interest since the pioneer work of Abramovitz in 1956 and that of Solow in 1957. With regard to the transfer of technology, it has been the subject of interest as a result of increasing magnitude of technology transfer between developed and developing countries on the one hand and between east and west on the other.

However specific studies concerning developing countries are few and they differ due to the varying reasons for the investigations.

This chapter is dedicated entirely to a review of some of these previous studies, particularly those based on the same tools as that used in this study i.e. the production function. The literature will be reviewed in the following manner: first studies measuring the growth of technical change and its impact on economic growth.* These studies according to the form of production function adopted are

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* *Recall again in our study we refer to technical change as the agent of technology transfer since most, if not all, the technological change in the developing countries in their early stages of development are transfered from abroad.*

studies using the Cobb-Douglas form and studies using Constant Elasticity of Substitution form. Second, studies using C-D and CES production functions but identifying the role assigned to technology transfer by using the marginal-productivity differential approach. Third, studies using an accounting approach as well as those using the Verdoorn Law. The last two types are included because they are directly comparable to our results. Finally, specific studies on Iraq.

4.2 PREVIOUS WORK WITH C-D PRODUCTION FUNCTION

The earliest work that attempted to measure technical change and then examine its impact on the growth of output is that of Solow (1957). This method is based on using an aggregate production function of the Cobb-Douglas form; by using data for the U.S.A. non-farm sector over the period 1919-1957 of Output, Labour and Capital, he estimated the rate of growth of technical change. The function he used was the following:

$$\frac{\dot{A}}{A} = \frac{\dot{q}}{q} - \alpha \frac{\dot{k}}{k} \qquad (4.1)$$

where q = output per man hour
k = capital per man hour
α = capital share in total output

Equation 4.1 interpretation is that technical change , $\dot{A}/A$, is equal to the change in output per man hour not accounted for by the change in capital per man hour.

Based on the value obtained for A/A he obtained an index of technical change. Setting coefficient, (A(t)), of neutral technical change in 1919 equal to 1 he found that during the period under study the level of technology had advanced by more than 80 per cent to 1.809. This is equivalent to 1.5 per cent per annum. This means that $\frac{7}{8}$ of the output per head increase should be attributed to the change in technology and only $\frac{1}{8}$ is traceable to an increase in capital per man.

Solow's study had opened the door for many studies; Massel (1960), for example, attempted to re-estimate Solow's index as applied to the U.S.A. manufacturing sector. However, the result obtained by Massel does not differ very much from that of Solow. In fact he found that technology advanced from 1.0 in 1919 to 2.9 in 1955.

Brown and Popkin (1962) made an interesting attempt to measure both neutral and non-neutral technical change which had occured in the American non-farming sector for the period 1890-1958. Indeed this was the first attempt to estimate non-neutral technical change using the Cobb-Douglas function, as follows:

$$Q = A\, L^{\alpha}\, K^{\beta} \qquad (4.2)$$

where, Q, L, K are output, labour and capital respectively

α and β are coefficients to be estimated and they are not restricted to sum unity.

For their purpose they divided the period under study into three "technological epochs": 1890-1918, 1919-1937 and 1938-1958. Each epoch started with an important innovation which essentially changed the relative marginal productivities of labour and capital. Furthermore, during each epoch no non-neutral technical change occured. In determining the end of each epoch they used their estimated production function to predict output in the next year over the boundary. If the estimated equation failed then that year did not belong to the old epoch and they would try another year. However, they estimated the non-neutral technical change by using the ratio $\alpha/(\alpha+\beta)$ which reflects the relative change in the marginal product of input factors.

The results obtained for the different epochs are below:

epochs	α	β	$\alpha+\beta$	$\alpha/\alpha+\beta$
1890-1918	0.98	0.49	1.47	0.67
1919-1937	0.44	0.60	1.04	0.42
1938-1958	0.51	0.53	1.04	0.49

The above results show that the share of labour relative to that of both factors declined during the second epoch, which means that the type of technical change taking place during the period 1919-1937 was of the labour saving type; it then changed during the period 1938-1958 to capital saving. Return to scale, $\alpha+\beta$, was 1.47 in between 1890-1918 and declined to 1.04 between 1919-1958.

Another early attempt to use an aggregate production function to measure technical change in the U.S.A. Gross National Product and identify it role in economic growth is by Nelson (1964). He attempted to estimate the shift of the function during the period 1929-1960 in three different forms.

First, the Cobb-Douglas of the following form was estimated.

$$\frac{\Delta Q}{Q} = \frac{\Delta A}{A} + \alpha \frac{\Delta L}{L} + (1-\alpha) \frac{\Delta K}{K} \qquad (4.3)$$

where

$\frac{\Delta Q}{Q}$ is the growth rate of Gross National Product

$\frac{\Delta A}{A}$ is the growth rate of disembodied technical change

$\frac{\Delta L}{L}$ is the growth rate of Labour input

$\frac{\Delta K}{K}$ is the growth rate of Capital input

The parameters α and $(1-\alpha)$ are shares of Labour and Capital in the Gross National Income. They were found to be 0.75 and 0.25 respectively.

The author found that for the period 1929-60 disembodied technical change grew by 2.5 per cent per annum, thus explaining more than 67 per cent i.e. $(\Delta A/A)/(\Delta Q/Q) = 0.6$. The remainder is due to the growth of Labour and Capital. This would indicate that the growth of technical change had been more important than that of Labour and Capital. If we look at the variation during the different subperiods, we find that in the periods 1929-47 and 1947-54 the growth rate of technical change was higher than that of the entire period, while in 1929-67 it was less, and in 1954-60 it was equal.

In his first specification Nelson did not take account of the strong complementarity between technical change and investment, by assuming that technical change is of the completely disembodied type. In contrast with his first specification he next assumed (following Solow, 1960), that some of the technical change has to be embodied in new capital equipment. For this purpose the following model was used.*

$$\frac{\Delta Q}{Q} = \left[\frac{\Delta A'}{A'} + (1-\alpha)\ \lambda_k - (1-\alpha)\ \lambda_k\ \Delta \bar{a}\right] + \alpha\frac{\Delta L}{L} + (1-\alpha)\ \frac{\Delta K}{K} \qquad (4.4)$$

where $\Delta A'/A' + (1-\alpha)\ \lambda_k$ is the rate of growth of technical change, that is $\Delta A/A$ in the previous specification, assuming that the average age of capital does not change; $(1-\alpha)\lambda_k$ is the part that needs to be embodied in new capital, and $\Delta A'/A'$ is that proportion which does not. Furthermore he assumed that all of technical change is embodied in capital goods, thus $\Delta A'/A'$ will vanish. Thus $\Delta a/a = (1-\alpha)\ \lambda_k - (1-\alpha)\ \lambda_k\ \Delta \bar{a}$ from which we can find the value of $(1-\alpha)\lambda_k$.

According to the full embodiment model it is found that since 1954 the rate of technical change has fallen sharply below that of the 1929-54 period. He also found that technological change

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* *His original function was*

$$\frac{\Delta Q}{Q} = \frac{\Delta A'}{A} + b\ (\Delta L/L) + (1-b)\ (\Delta J/J)$$

where $\Delta J/J$ is the growth rate of a quality - weighted number of machines with new machines given a greater weight than older machines, reflecting the newer technology embodied in them
Then he approximated

$$\frac{\Delta J}{J} = \frac{\Delta K}{K} + \lambda_k - \lambda_k\ \Delta \bar{a}$$

where λ_k is a percentage by which technology improves and $\bar{a}$ the average age of capital.

variations during the subperiods were relatively well explained by the growing average age of Capital before 1947. Moreover, it was found that technical change embodied in new capital explained not less than 79 per cent of the disembodied previously estimated during the various subperiods, i.e. $[(1-\alpha)\lambda_k]/(\Delta A/A) = 0.79$. While the average age of capital explained the remainder.

Finally, similar to capital, different individuals in the labour force are of different vintages, distinguished by age and training and/or education. Individuals of the current vintage are thus more productive than individuals of earlier vintages, so that the third attempt tried to capture the rate of disembodied technical change in them. In order to do this Nelson used the following specification;

$$\frac{\Delta Q}{Q} = \frac{\Delta A^*}{A^*} + \alpha\lambda_l + (1-\alpha)\lambda_k - (1-\alpha)\lambda_k \, \Delta\bar{a} + \alpha \frac{\Delta L}{L} + (1-\alpha) \frac{\Delta K}{K} \quad (4.5)$$

where λ_l is the rate of improvement in the average quality of the labour force. The term $\Delta A/A$ in the usual Cobb-Douglas is now broken down into four components; of them $\Delta A^*/A^*$ represented that improvement not directly embodied either in capital or in labour, such as more efficient allocation of resources and better management practices. λl represents technical change embodied in the labour force and the other two terms are technical change embodied in capital as defined before.

Moreover, following Denison (1962), Nelson has broken $\alpha\lambda_l$ into three components, the first one represents improvement in labour quality due to improvement in education attainment (he assumed that each additional year of education increases labour quality by approximately 6 per cent). Second, another one represents the improvement in labour quality resulting from the changing age-sex composition of the labour force and he assumed that the rate of improvement in composition proceeded at 0.1 per cent per annum. The third one represents improvement as a result of a decline in the average working week. According to him, as the average work week declines, labour productivity per man hours increases but with diminishing returns, so that he assigns a rate of improvement in average labour quality due to declining average hours work equal to 0.3 for the first period, increasing to 0.4 per cent in the second subperiod and remaining constant for the period 1947-60 at 0.2 per cent.

Nevertheless, the rate by which quality of labour had increased, $\alpha\lambda_1$ is found to be constant and equal to 1.0 per cent per annum. The implication of this means that half of the shift in the production function is due to embodied technical change in the labour force and the other half due to technical change embodied in capital goods, during the period 1929-60. During the subperiods technical change embodied in capital shows a higher growth rate than that of labour.

Jorgenson and Griliches (1967) argued that the previous studies such as Solow (1957), Massel, (1960) etc., have exagerated the magnitude and contribution of technical change in growth, so that "if economic theory underlying the measurement of real product and real input fctors is properly exploited the role to be assigned to growth in total factor productivity is small."

In their attempt and in order to accurately measure technical change in the U.S.A. private domestic economy for the period 1945-65, they used data corrected for firstly, errors of aggregation in combining investment and consumption goods and input factors services; secondly errors of measurement in the price of investment goods arising from the use of prices for inputs into the investment goods sector, rather than the use of prices of output from this sector. Thirdly, errors from using the stock of labour and capital rather than their flow of services, and fourthly, errors resulting from the aggregation of investment goods and capital services on the one hand and labour and services on the other. They found that "after elimination of aggregation errors and correction for changes in the rates of utilization of labour and capital stock, the rate of growth of input explains 96.7 per cent of the rate of growth of output; change in total factor productivity explains the rest", in other words movements along the production function explain 96.7 per cent of the observed changes in the pattern of productivity; while the shift of the function explains only 3.3 per cent.

Earl Brubaker (1968) in his attempt to measure the technical change which occured in the U.S.S.R. during the period 1928-61, used three forms of the Cobb-Douglas production function.

First

$$\frac{\Delta Q}{Q} = \frac{\Delta A}{A} + \alpha \frac{\Delta L}{L} + (1-\alpha) \frac{\Delta K}{K} \qquad (4.6)$$

The value assigned to α is that suggested by Moorsteen and Powell (1966), which is 0.70 leaving a value of 0.30 for capital. However, the resultant value for technical change is an annual growth rate of

3.5, which means that technical change is responsible for 52 percent of the growth of output. This means that the conventional input factors accounted for 48 percent of the growth of output. Furthermore they found a high variation in the contribution of technical change to the growth during different subperiods. In fact the variation ranged between 70 to 30 percent.

Second

In order to capture the importance of human capital, which may well be an essential component in the large residual obtained by the first specification, they introduced it as a factor of production. Thus the production function becomes as follows:

$$\frac{\Delta Q}{Q} = \frac{\Delta A^*}{A^*} + \alpha \left[\frac{\Delta L}{L}\right] + (1-\alpha) \left[\frac{\Delta K}{K}\right] + C \left[\frac{\Delta H}{H}\right] \qquad (4.7)$$

Where H stands for human capital and C represents the elasticity of output with respect to human capital.

By applying values of 0.59 for α and 0.055 for C they obtained a value of 3.2 to $\Delta A/A$ and at least 90 percent of the residual, which is calculated as $(\Delta A^*/A^*)/(\Delta A/A)$, remains.

Third

Following Nelson (1964), Brubaker assumed that entire technical change is embodied in new capital and the equation used was thus:

$$\frac{\Delta Q}{Q} = -\left[\frac{\lambda \Delta \overline{a}_t}{1-\lambda \overline{a}_t}\right] + \alpha\frac{\Delta L}{L} + C\frac{\Delta H}{H} + e\frac{\Delta M}{M} + d\frac{\Delta K}{K} \qquad (4.8)$$

Where all symbols stand as previously, and M stands for other capital, λ is the rate of growth in quality of capital and a_t refers to the average age of K at time t. However, the empirical results of equation 4.8 show that embodied technical change in capital input was the most important contributor to growth in the U.S.S.R. during the periods 1928-37, 1950-58 and 1958-1961; these contributions were respectively 48.49, 36.32 and 44.83 percent.

Balasubramanyam (1973) in his attempt to evaluate the impact of the Technical Collaboration Agreements (TCAs) on the Indian industrial sector, over the period 1957-65, tackled this issus from different angles. In the absence of a satisfactory quantitative variable indicating the extend and quality of technology imported, he used the number of technical collaboration agreements as a proxy variable for the extend of knowledge imported. His sample covered 16 industries.

He first tried to assess the impact of the number of agreements on the percentage change in labour productivity, capital productivity, and the growth in the ratio of capital to labour employed by the industries included in his sample. However, by using the Spearman-Rank correlation technique he found that correlation coefficients showed that the association of the number of agreements with the above 3 indicators were respectively 0.28, -0.25 and 0.20; and all 3 coefficients are statistically insignificant. This provided the evidence that there is no relationship between imported know-how and growth in Indian industrial productivity. Furthermore, he concluded that using the number of agreements as a proxy variable to technology imported might not be the perfect choice.

At another stage of his analysis, the Cobb-Douglas production function was estimated for the sample of TCAs, Indian, and foreign firms. These estimates not only provide an alternative means of analyzing productivity changes for these groups of firms during the years 1960 to 1965, but also enabled a study into the changes in the productive shares of labour and capital over the period for each of the groups of firms. Furthermore, the number of TCAs is used as an additional factor of production for these groups of firms.

In doing so he started with the ordinary C-D function using data on value added, wages and salaries, and total assets of the firms. Then he fitted another function in which the number of TCAs is used as an input factor. The function fitted using TCAs gives a higher R^2 and all the coefficients are significant. Moreover, introducing the number of agreements as a variable resulted in an increase in the magnitude of the labour coefficient and a decline in that of capital. This change in the relative size of the coefficients with the introduction of the number of agreements as a variable suggest that imported know-how may have had a positive impact on labour productivity, while reducing the productivity of capital.

As a final stage of his analysis, the contribution of two factors of production was tested as regards the growth in value added of the two kinds of firms over the period 1960-65. The author estimated the following function, using cross-section data:

$$\text{Log}\left[\frac{V_{65}}{V_{60}}\right] = \alpha_0 + \alpha_1 \text{ Log}\left[\frac{W_{65}}{W_{60}}\right] + \alpha_2 \text{ Log}\left[\frac{A_{65}}{A_{60}}\right] \qquad (4.9)$$

His result showed that, in the case of TCA firms, a low labour coefficient is obtained and a negative one for capital. Accordingly his conclusion was that TCA firms experienced a decline in capital productivity and they may have been subject to a higher degree of unutilized capacity.

However, his comparative analysis, using labour-, capital-, and total factor productivities as well as that obtained through using a production function led him to conclude:

1 In terms of overall efficiency, the Indian firms seem to have enjoyed better performance than the TCA firms.
2 Transfered know-how contributed to the growth of labour productivity of the TCA firms, but only by increasing capital in use.
3 The TCA firms were less efficient than the Indian firms in the use of capital.

The results of Balasubramanyam can not be taken as solid evidence for proving the ineffectiveness of technology transfer, since it is based on a small sample size of less than 15 firms in his sample of 16 industries. Also he approximates the whole process of technology transfer by the number of Technical Collaboration Agreements, which by no means can be generalized as being the case for all other channels.

Bruton (1967) examined the sources of growth of Gross Domestic

Product in 5 Latin-American countries during the period 1940-64, and compared it with a group of developed countries.* One of his objectives was to find an explanation for the variation in the growth rate of the residual, which is the most interesting feature in this study.

The model used is a simple Cobb-Douglas function. Technical change is measured as a residual in the manner of equation (4.3), where the values used for α and β are the relative shares of labour and capital in GDP.

The results he obtained show that the growth of technical change calculated as a residual varies considerably between countries, as well as subperiods. With the lowest rate reached in Argentina, 0.006 for the period 1960-1964, resulting in a large retardation in the growth of output, the highest rate was reached in Mexico during 1940-45 at a contribution rate of 9.74 percent of the growth of output.

He also analyzed the effects of changes in total factor inputs and output on the change in technical change, or the residual, as follows;

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* *The LDCs (Lesser Developed Countries) included in his study are: Argentina, Brazil, Chile, Colombia, and Mexico. While those included from the developed countries are: Belgium, Canada, France, Italy, Japan, The Netherlands, Norway, Sweden, The United Kingdom, United States and West Germany. The period covered, centred mostly on 1949-59.*

1 In order to reveal the relationship between technical change and the factor inputs he ran the former on the latter. Theoretically the improvements embodied in capital equipment and from better education, and better trained workers, suggests that $\Delta A/A$ and $\Delta TFI/TFI$ should be positively correlated, i.e. TFI is a carrier of technical change.

$$\frac{\Delta A}{A} = a + \alpha \frac{\Delta TFI}{TFI} \qquad (4.10)$$

2 To find the effect of an increase in output on the change in technical progress the relation used was:

$$\frac{\Delta A}{A} = a + \alpha \frac{\Delta Q}{Q} \qquad (4.11)$$

However, the above relationships are estimated for both the 5 LDCs as well as for those studied by Denison. The estimated equations are:

For developed countries;

$$\frac{\Delta A}{A} = 2.47 + \underset{(0.21)}{0.17} \frac{\Delta TFI}{TFI} \qquad R^2 = 0.02 \qquad (4.12)$$

and

$$\frac{\Delta A}{A} = 0.64 + \underset{(0.10)}{0.44} \frac{\Delta Q}{Q} \qquad R^2 = 0.51 \qquad (4.13)$$

For LDCs;

$$\frac{\Delta A}{A} = 1.26 + \underset{(0.40)}{0.06} \frac{\Delta TFI}{TFI} \qquad R^2 = 0 \qquad (4.14)$$

and

$$\frac{\Delta A}{A} = -1.71 + \underset{(0.10)}{0.74}\frac{\Delta Q}{Q} \qquad R^2 = 0.71 \qquad (4.15)$$

Equations (4.12) and (4.14) show that the growth of total factor inputs does not explain anything; this is clear form the very low value of R^2. But when the author estimated equation (4.14) for the latter subperiods, he found an increasing relationship between total factor inputs and total factor productivity; this is possibly the result of the increasing advance of knowledge embodied in the input factors, although he did not give this explanation.

Also, equation (4.15) shows that for developing countries the change in total factor productivity depends mostly on the change in output. With regard to the developed countries the negative value of the constant term implies that total factor productivity growth is negative unless output is growing at a higher rate.

In spite of the comprehensiveness and originality of Bruton's work, two defective points need to be mentioned. First, it seems from the regressing of changes of output on changes of total factor inputs that there is an increasing return to scale while the basic assumption of Bruton's model is based on the constant return to scale. Second, having running changes of total factor productivity on changes of total factor inputs, and finding that the changes in the latter explained nothing of the changes in the former, Bruton concluded that improvements of inputs have no effect on total factor productivity, and thus this conclusion is not easy to accept.

Chen's (1977) study was made to cover the economies of 5 Asian countries as well as for the individual sectors: agriculture, manufacturing and services.* The countries included in his study were: Hong Kong, Japan, Korea, Singapore, and Taiwan. The main objective of his study was to quantify the contribution of total factor inputs and that of technical change to growth of output and to compare the results with existing evidence on developed and developing economies.

The most interesting thing to us in this study is to find by what rate technical change or total factor productivity is growing in aggregate as well as of the sectoral level, and then to see what contribution is made by this factor to economic growth at both levels of aggregation.

Chen's methodology is based on the Cobb-Douglas production function. The input elasticities used are 0.4 for that of capital and 0.6 for that of labour. Two justifications are given for assigning these values. Firstly, from the available data, the factor share of the economies under study remained reasonably constant over the underlying period. Secondly, the resulting calculations are, in general, insensitive to the values of those elasticities. The data for the economy as a whole is for the period 1955-70; for the agricultural and services sectors 1955-70 for Japan and Taiwan only,

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* *The services sector as used in Chen's study includes construction, public utilities, and transportation and communication in addition to commerical, social, and personal services.*

and Korea 1960-70. Data for the manufacturing sector covers all 5 countries for the period 1960-70 except for Japan and Taiwan where it covers 1955-70.

For the aggregate level Chen found that total factor productivity was growing in a range; its highest was reached in Japan with 5.58 percent per annum and its lowest was reached in Singapore with 3.62 percent per annum. As a contribution to growth Chen's conlusion is that, excluding Hong Kong, over 53 percent of growth of real national income is made through technical progress.

For the three sectors the growth of technical change varied considerably. In agriculture it ranged form 1.2 in Taiwan to 4.24 in Japan. With regard to its contribution to growth, it was found to be between 32.0 percent in Taiwan and 42.0 percent in Japan. In the manufacturing sector technical change registered its highest growth rate in Taiwan, 4.58 percent, and its lowest in Hong Kong with 2.03 percent. As a contribution to growth of technical change the highest contribution was made in Taiwan with 39.8 percent, and the lowest was in Singapore with 18.3 percent. For the services sector, the technical change growth rate was at its highest in Taiwan at 5.38 percent and at its lowest in Japan at 2.78 percent per annum. This means that the contribution to growth lay between 55.3 percent for Taiwan and 48.3 percent for Japan.

Chen, however, went even further in examining the relationships among the various growth rates (the contributions of capital and labour to growth, total factor productivity, and output growth) and he compared his results with that of advanced countries, to throw some light on the different growth source patterns. These relations are; ΔQ on ΔTFI, where TFI equal to $\alpha\Delta L/L + b\Delta K/K$, which is the percentage point of input factors' contribution to growth; ΔQ on $\beta\Delta K/k$; ΔQ on $\alpha\Delta L/L$; and ΔQ on $\Delta A/A$.

The above equations were estimated for the 5 economies as a whole as well as for 8 European countries studied by Denison (1967).* The results obtained are:

$$\frac{\Delta Q}{Q} = 4.036 + \underset{(0.264)}{1.041}\frac{\Delta TFI}{TFI} \qquad R^2 = 0.564 \qquad (4.16)$$

$$\frac{\Delta Q}{Q} = 4.819 + \underset{(0.260)}{1.462}\frac{\Delta K}{K} \qquad R^2 = 0.725 \qquad (4.17)$$

$$\frac{\Delta Q}{Q} = 7.863 + \underset{(0.698)}{0.273}\frac{\Delta L}{L} \qquad R^2 = 0.01 \qquad (4.18)$$

$$\frac{\Delta Q}{Q} = 3.920 + \underset{(0.315)}{1.049}\frac{\Delta A}{A} \qquad R^2 = 0.481 \qquad (4.19)$$

The interpretation he gave to the above equations is that 56 percent of the variations in the growth of output is explained by a change in the rate of growth of total factor inputs, 73 percent of the variation in the output rate of growth is explained by the variations in the growth rate of capital, Labour failed to explain anything on the variation in output growth rates. Indeed even if the labour force did not grow, output grew at the high rate of 7.9

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* *The countries included in Denison's study are: Belgium, Denmark, France, Italy, The Netherlands, Norway, The United Kingdom and West Germany.*

percent. The last equation in the estimated set by Chen is of great interest to us. It shows the percentage of change in the growth of output as explained by the change in total factor productivity. The results suggest that more than 48 percent of the variation in output can be explained by total factor productivity.

The results of the above relations for the developed countries are:

$$\frac{\Delta Q}{Q} = 1.543 + \underset{(0.736)}{1.416}\frac{\Delta TFI}{TFI} \qquad R^2 = 0.346 \qquad (4.20)$$

$$\frac{\Delta Q}{Q} = 1.270 + \underset{(1.470)}{3.609}\frac{\Delta K}{K} \qquad R^2 = 0.463 \qquad (4.21)$$

$$\frac{\Delta Q}{Q} = 2.501 + \underset{(1.270)}{1.613}\frac{\Delta L}{L} \qquad R^2 = 0.187 \qquad (4\ 22)$$

$$\frac{\Delta Q}{Q} = 1.370 + \underset{(0.190)}{1.193}\frac{\Delta A}{A} \qquad R^2 = 0.849 \qquad (4.23)$$

When the two sets are compared to each other one can come to the following conclusions:

- The change in total factor productivity or the technical change growth rate are responsible for explaining a higher proportion of the variation in the growth rate of output in developed than in developing countries.

- Changes in the growth rate of capital explained a higher proportion of variation of output growth in developing countries than in developed countries.

- The two patterns of growth are different, the one in the developing countries still depends on the growth of inputs, while the second pattern, which is adopted in developed countries, depends on the contribution of technical change as a fuel to the growth engine.

One further point needs to be mentioned, Chen unlike Bruton (1976) did not try in his study to find the possible explanation of the variation of total factor productivity. He might have been aware of Bruton's findings when total factor inputs failed to explain any of the variations in total factor productivity.

Robinson (1971) attempted to encompass the importance of structural change and foreign exchange inflows in economic growth, in thirty-nine less developed countries. His methodology is based on a Cobb-Douglas function, and the weight used is not that of factor shares in the output, instead they are estimated through regression.

In finding the role played by structural change he used a two sectors model. The structural change represented by the transfer of labour and capital from the less productive sector to the high productive sectors, so that his function becomes:

$$\frac{\Delta Q}{Q} = B_0 + B_1\ INVR + B_2\ L + B_3 DKS + B_4 DLS \qquad (4.24)$$

WVR is the ratio of investment to GNP, representing capital

L is the growth of the labour force

DKS is the rate of transfer of capital and measured as the average annual absolute change in the share of non-agricultural sector in GDP

DLS is the rate of transfer of labour measured by estimating the average annual absolute change in the percentage share of the population living in the cities.

Technical change measured by the mean of equation (4.24) as the difference between the observed rate of growth of output and the rate estimated by equation (4.24). However, the results obtained show that labour contribution to growth is 20 percent, that of capital 52 percent, that of transfer of labour and capital 16 percent. According to those figures the contribution left to technical change is 12 percent.

In the author's next step he incorporated the foreign balance inflow into equation (4.24). As a measure of the foreign balance inflow he used the ratio of the net foreign balance. His result shows that the role played by the foreign balance is significant. Furthermore, when the foreign balance inflow is included in the equation the magnitude of the residual, surprisingly increases.

One important feature, which should be noticed in Robinson's model is its ignorance of social and political differences among the countries included in his study. Also it does not take into account the different stage of development, which do make a difference, especially on the magnitude of the residual.

Another point which deserves to be mentioned is the low explanatory power of the model; this can be verified by the low value of, $R^2 = o.35$. This might be the result of the point mentioned above, as well as the mis-specification of the variables and the way in which they are measured.

Bonellie (1975), in his attempt tried to estimate empirically the causes and factors besides the pure technological change that affected the magnitude of the residual. His study covered two-digit Brazilian manufacturing industries for the period 1969-1970. The variables included in his analysis are:

- percentage change in the degree of capital utilization
- percentage change in the ratio of intermediate inputs per unit of output
- percentage market share of foreign firms
- index of industrial concentration
- average size of industrial plants
- index of skill of labour force
- percentage share of output due to new plants
- index of payments for transfer of technology per unit of output
- percentage growth rate of capital stock
- gross rate of return
- index of payments for patents, manufacturing licences and trademarks per unit of output
- percentage change in the average size of industrial plants rate of profit on gross value added.
- percentage share of foreign firms in the capital of a given industry
- percentage share of male employees in total employment

When constructing the relative shares of these variables in the residual, he used the factor analysis technique and found that 77.3 per cent of the residual is explained by the growth rate of capital stock and percentage output due to new plants, and an additional 10 percent was due to payment for patents, foreign technology purchases and labour force skills. Furthermore he found that some of the other variables, such as the percentage of males in the labour force, and savings in intermediate inputs have limited power in explaining the growth of the residual.

One important conclusion that can be drawn from his findings, is that technology for which growth capital stock among other factors has been taken as a proxy variable to represent its embodied type has been responsible for 88.3 per cent of the growth rate of the residual.

Another study using the same approach is that by Adams, J. and Balu, B., (1979). This study attempted to determine the importance of technology among other factors on the land productivity in Rajasthan in India. He used tractors, fertilizer application and pumps as measures of technical change and found that these factors contributed far less than land, labour force, animal power and rainfall etc.

Belhoul (1983) in her study tried to identify the factors that significantly affect the rate of technologial integration. In other words, technology transfer is highly influenced by the social and economic conditions of the recipient countries. It is therefore intended to explore these conditions and to gain a quantitative insight. In doing so the author attempted to use every aspect of the socio-economic characteristics of developing countries in order to have a large variety of elements of which only the important aspects may be later pin pointed. As a result, as many variables as possible were used. 30 social and economic variables were included in her analysis. The sample covered nearly 45 countries for the industrial sector.

The method used was the same as that of Bonelli (1975), in his study of the Brazilian manufacturing industries. As a representative variable for the technological integration an index (of the integration of technology) was defined as the ratio of growth of gross industrial product for the period 1970-1977 over imported technology for the same period.

The results suggest that the most important factors, among the 30 variables, affecting technology transfer were adult literacy rate, imports of manufacturing goods, and radio receivers per 1000 of the population

These variables identified as accurate indicators of the rate of technological integration and explain a significant 61 percent of its total variance.

One can notice from the results of this study that the specified variables are not those normally associated with the effective transfer of technology, such as research and development, number of engineers and scientists, etc. However, this might be a results of including a wide spectrum of countries in the sample, which differ substantially in their levels of development. Another possibility for the odd result is that the use of the ratio of gross industrial product in relation to imported technology might not be the right specification for quantifying technological integration.

4.3 PREVIOUS WORK WITH THE CES PRODUCTION FUNCTION

In addition to the literature using the Cobb-Douglas production framework, another approach has been extensively used in the market economies.* The pioneer work on a centrally planned economy using this function is that of Weitzman (1970).† His study was based on an annual series of output, labour and capital from the soviet industrial sector for the period 1950-1969; in it he used both C-D and CES production functions, and employed two forms of disembodied technical change.

Symbolically his CES form with the two specifications of disembodied technical change are:

$$Q = \gamma\, e^{\lambda t}\, [\, \delta K^{-\rho} + (1-\delta)L^{-\rho}]^{-1/\rho} \qquad (4.25)$$

and $$Q = \gamma\, e^{\lambda t+\lambda t^2}\, [\, \delta K^{-\rho} + (1-\delta)L^{-\rho}]^{-1/\rho} \qquad (4.26)$$

Among the two C-D specifications and the two specifications of

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* *Reference should be made to Brown (1966), Lovell (1973), Nerlove (1967). The latter is a summary of the many previous studies.*

† *See also Bairam (1988), Bergson (1979), Cameron (1981), Whitesell (1985), Desai (1985), Brown and Neuberg (1973) etc.*

CES (4.25 and 4.26) Weitzman, found that the best specification is that of 4.25. According to this specification, which provides an elasticity of substitution of around 0.403* , the annual growth rate of technical change was 2.05 per cent per annum.

Equation 4.26 attempted originally to capture a continuous accelerating or decelerating change in technical change.

For an interpretation of his result he employed the following relationship:

$$G_Q = G_A + h_K G_K + h_L G_L \qquad (4.27)$$

Where G denoted the relative rate of growth of the variables and h_K and h_L are imputed factor shares.† According to equation 4.27 acceleration (deceleration) of the growth rate of output may be the result of a increase (decrease) in the rate of growth of technical change or an increase (decrease) in the rate of growth of input factors and/or an increase (decrease) in the relative share of the fast growing input.

However, Weitzman found statistical evidence that the imputed

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* *Norlove (1967) listed a number of studies that have found elasticities of substitution below unity. Another recent study proved this case for the American economy (Bergson, 1979)*

† *The imputed shares from specification 4.25 as derived by Weitzman are:*

$$h_K = \delta\gamma^{-\rho} e^{-\lambda t} \left[\frac{Y}{K}\right]^{\rho}$$

and $$h_L = (1-\delta)\gamma^{-\rho} e^{-\lambda t} \left[\frac{Y}{L}\right]^{\rho}$$

share of capital fell from 86 percent in 1950 to 44 percent in 1969. To interpret these figures, a 10 percent increase in capital in 1950 would have increased output by 8.6 percent, while the same increase in capital in 1969 would have only increased output by 4.4 percent. Moreover, since capital increases more rapidly than labour and its share is declining over time, and since the substitutability between labour and capital is below unity, at the same time technical change increases at a constant rate. This would give us sufficient explanation for the deceleration in the growth of output. Therefore the main conclusion of Weitzman is that technical change must increase at a higher rate if a continued high growth rate of output has to be achieved.

Rosefielde and Lovell (1977) in their research looked at the sources of growth in the Soviet manufacturing sector for the period 1950-1974, by using a CES function with a variable growth rate of technical change specification. Their approach is different from the previous studies in two main aspects.

1. They tried to overcome the problem of valuation, "which is continuous to obscure the analytic significance of any parametric estimation of the post-war Soviet economic growth." For doing so they tested the CES specification of Soviet growth in adjusted factor cost prices. Five sets of data were used for this purpose.

2. They used a two-step linear-non-linear technique in their estimation. This is because of the well known problem that parameters' estimates obtained by using the non-linear method

maynot be insensitive to the starting value given to the parameters. However, in the first stage of this work a linear approximation to Equation 4.26 takes the form:

$$Ln\left[\frac{Q}{L}\right] - Ln\ \gamma + \lambda t + Bt^2 + \delta\ Ln\left[\frac{K}{L}\right] - \frac{1}{2}\rho\ \delta\ \left[Ln\left[\frac{K}{L}\right]\right]^2 \qquad (4.29)$$

In the second stage the parameter estimated obtained from Equation 4.29 are used as initial values in Equation 4.26.

The result of using the above approach and the 5 different sets of data are similar. All point to an extremely low elasticity of substitution (between 0.16 and 0.18). In addtion all estimates give a relatively low capital intensity parameter (between 0.40 and 0.52). Technical change, on the other hand, appears to be an increasingly important contributor to the output growth. According to them, annual rate of technical change increased from less than 1 percent in the early 1950's to over 6 percent in the early 1970's.

Another study by Sapir (1980) undertook to find the sources of growth for the Yugoslavian manufacturing sector. He dedects that manufacturing output has stagnated if the period from 1950-1965 compared with the period from 1965 to 1974, for the periods 1955-1965 and 1966-1974. This was based on the socio-economic reforms introduced in 1965*.

For this purpose he estimated the following equation:

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* *Through these reforms economic agents were allowed to operate outside government control.*

$$Ln\left[\frac{Q}{L}\right] = Ln\ \gamma + \lambda t + \mu D + \delta Ln\left[\frac{K}{L}\right] - \frac{1}{2}\ \rho\ \delta(1-\delta)\left[Ln\left[\frac{K}{L}\right]\right]^2 \quad (4.30)$$

and then by using the parameter estimates from equation (4.30) as initial guesses the following form is estimated.

$$\left[\frac{Q}{L}\right] = \gamma\ e^{(\lambda+D)t}\ \left[\ \delta\left[\frac{K}{L}\right]^{-\rho} + (1-\delta)\right]^{-1/\rho} \quad (4.31)$$

Where D is a dummy variable which takes the value 0 for the period 1955-1965 and 1 for the period 1966-1974.

However, when a dummy variable is included in testing for the possible decline in the rate of technical change after 1965, the author found that most of the estimates turned out to be not significant, including that corresponding to the dummy variable itself. On the other hand, when the dummy variable is removed from his equation, most estimates turn out to be significant. Thus he considered the last estimate as the prefered one. The results of his estimates show that the capital intensity parameter, δ, was low at 0.218, with the elasticity of substitution at around 0.319 and the constant rate of technical change approximately 4.8 percent per annum.

In order to improve his estimates he adjusted his data for the degree of utilization and then re-estimated his equations. However, even after the data adjustment the dummy variable coefficient was still insignificant but other parameters were improved. In addition the capital intensity parameter increased sharply, to 0.61, and the elasticity of substitution dropped to 0.14 and the growth rate of technical change declined to 3.4 percent per annum.

So as to estimate the contribution of input factors and that of technical change to growth of output, he calculated the inputed shares of capital and labour, and then combined them with the growth rate of these variables. He thus found that among the various contributors, technical change played a major role in the growth of output. Its contribution was approximately 38 percent for the period 1955-1965 and 63 percent during the period 1966-1974, leaving the remainder of the contributions to labour and capital.

Kemme (1987) has used the same method as that used by Sapir (1980) but he gave rather a different enterpretation to the dummy variable. He argued that in some cases, as a result of government policy changes, technical change might increase by discrete changes so therefore he used a dummy variable instead of the t^2 in his specification for the growth of technical change. However, in his study on Polish industry he found a discrete increase in the growth of technical change in 4 industries out of 10 during the period 1973-1977.

Bairam, 1988 in his attempt looked at the rate of growth of technical change in nine major branches of Soviet industry, for the period 1962-1974. The novel aspect of this study is to measure the rate by which technical change grew along with degree of return to scale.

Gross output, employment (number of persons employed) and fixed capital stock data are used for estimating the different functional forms employed in this study. As a functional forms he make uses of the following:

- Constant elasticity of substitution with non-constant return to scale and constant rate of technical change.

$$Q = \gamma\ e^{\lambda t}\ [\ \delta K^{-\rho} + (1-\delta)L^{-\rho}]^{-\upsilon/\rho} \qquad (4.32)$$

- Cobb-Douglas with non-constant return to scale and constant rate of technical change.

$$Q = A\ e^{\lambda t}\ L^{\alpha}\ K^{\beta} \qquad (4.33)$$

In order to discriminate between the above two forms he uses t and F-test statistics. With regard to the estimation techniques, three estimation methods were used: Ordinary Least Squares; Instrumantal variables; and Maximum likelihood.

The main conclusions of this study are: First, the different estimation methods give similar, if not identical, results. Second the estimated rate of growth of technical change varies from 1-2 per cent per annum in Electricity and Ferrous Metallurgy to 6 per cent per annum in Machine Building and Metal Working and Chemicals. Third, the results reveal constant returns or decreasing returns to scale in all branches but three. Finally, empirical results suggest that the Cobb-Douglas production function is the underlying production structure of seven branches out of ten.

4.4 STUDIES USING MARGINAL-PRODUCTIVITY DIFFERENTIAL APPROACH.

This approach again is based on the production function technique. It is simply a comparison between marginal productivity of machinery imported from outside the country and marginal productivity of domestic machinery.

An early attempt using this approach is of Weitzman, (1979) who used a production function analysis to estimate the marginal productivity of machinery transfered from western countries to Soviet industry and for other sub-sectors during the period 1960-1975. The focus was on whether imported western capital has the same productivity as domestically produced capital in the USSR, which is a narrow test for the importance of technology transfered.

The basic specifications for testing the above hypothesis are:

$$Q = Ae^{\lambda t} \left[K_d + \omega K_i\right]^{\alpha} L^{1-\alpha} \qquad (4.34)$$

(Cobb Douglas with constant growth of technical change)

$$Q = Ae^{\lambda_1 t+\lambda_2 t^2} \left[K_d + \omega K_i\right]^{\alpha} L^{1-\alpha} \qquad (4.35)$$

(Cobb Douglas with variable growth of technical change)

$$Q = Ae^{\lambda_1 t}\left\{ \left[\delta K_d + \omega K_i\right]^{-\rho} + (1-\delta)\ L^{-\rho}\right\}^{-1/\rho} \qquad (4.36)$$

(CES with constant growth of technical change)

Where K_d is domestically produced Soviety capital (more accurately, Soviet capital of a non-western origin) K_i is Soviet capital transfered from western countries

In all cases, the test is whether $\omega = 1$ or not.

He then assigned values of 0, 1 and 100 to ω and found the effect on the sum square error. However, he found that the sum square error of a residual from widely different values of that parameter is not affected significantly, so he therefore did not reject the hypothesis that $\omega = 1$.

Furthermore, two alternative functional forms have been tried. In those forms he treated imported and domestically produced capital as separate factors of production i.e.:

$$Q = Ae^{\lambda t} K_d^{\alpha} K_i^{\beta} L^{1-\alpha-\beta} \qquad (4.37)$$

(Cobb-Douglas with constant rate of return to scale and with constant growth of technical change).

$$Q = Ae^{\lambda_1 t+\lambda_2 t^2} K_d^{\alpha} K_i^{\beta} L^{1-\alpha-\beta} \qquad (4.38)$$

(Cobb-Douglas with constant return to scale and variable growth rate of technical change).

Prior to this he considered equations 4.37 and 4.38 as bad specifications because the elasticity of substitution between domestic and imported capital has to be higher than the elasticity of substitution between capital and labour. Furthermore, these specifications are biased towards yielding a high marginal productivity of imported capital because there is so little of it relative to the other factor, and there is a severe restriction on the degree to which domestic capital can be substituted for it. The obtained results of 4.37 and 4.38 give either a negative value to β or it is statistically insignificant.

The final conclusion drawn is that there is no evidence to suggest that technology transfered from the western countries is more productive or less productive for the Soviet economy than capital of non-western origin.

Toda (1979) in his study on the differences of marginal productivities of imported technology with those of domestic technology, pointed out that the comparison should be made when both types of capital are used in the same quantities. And since the quantity of imported capital is less than that of domestic capital its marginal productivity should be higher. Another point he argues is that the Soviet Union is eager to import technology from abroad, not because capital is in short supply, but because it is technologically difficult to find the close domestic subsitutes for imported Capital goods. If so, intra-capital should be inelastic.

In his specified production function, Toda involved the two issues mentioned above; i.e. the elasticity of substitution between the two kinds of capital as well as the difference in the quantities of both types capital. His function may be considered at two levels, at the first the output is taken as a function of the two input factors, i.e. capital and labour, as follows:

$$Q = A\, J^{\alpha}\, L^{1-\alpha} \qquad (4.39)$$

Where J is composite capital.

At the second level, the capital input is considered as a composite, consisting of imported capital, M, and domestic capital K, so that

$$J = [\, \delta K^{\rho} + (1-\delta)\, M^{\rho}\,]^{1/\rho} \qquad (4.40)$$

The reason for choosing the CES form is because it includes C-D and the additive form as a special case. When ρ approaches 0, σ approches 1, thus the function is of the C-D form, on the other hand the additive form is obtained by setting $\rho = 1$

With regard to the type of technical change the author experimented with two types i.e., neutral and the capital-augmenting type. However he found that the specification of capital improvement which augments the capital transferred at a quadratic rate is the better fit. Thus equation 4.35 after introducing technical change becomes:

$$J = \left\{ \delta\, K^{\rho} + (1-\delta)\, [e^{\lambda t^2} M] \right\}^{1/\rho} \qquad (4.41)$$

Finally by substituting equation 4.41 into the production function (4.39) and using the ratios y=(Y/L), k=(K/L) and m=(M/K) and transferring them logarithmically his final production function looks like:

$$Lny = LnA + \alpha \left[LnK + \left(\frac{1}{p}\right) Ln\left\{\delta + (1-\delta) \left[e^{\lambda t^2} m\right]^{\rho}\right\}\right] + Lnu \quad (4.42)$$

The results obtained were coefficient α, representing the share of composite capital at 19 percent; the distribution coefficient for domestic capital, δ, which was as high as 97 percent; also the coefficient for capital augmentation, λ was positive, indicating the ever increasing efficiency of imported capital; and finally the elasticity of substitution between the 2 types of capital which was nearly 1, (0.9889).

His final conclusion, is that the difference between productivity of domestic capital and imported capital is not statistically significant and that their elasticity of substitution is very close to unity. Thus the two types of capital are indistinguishable with regard to their contribution to the growth of industrial output.

4.5 STUDIES USING THE SOURCES OF GROWTH FRAMEWORK

An alternative approach isolating the contributions made by the input factors, viz: labour, capital and land, and total factor productivity to the growth of output, is outlined below. This approach is identified with the work of Denison (1962, 1967, 1979). In this approach the production function is used in an accounting format. The main advantage of this approach is that instead of estimating the parameters of the production function and using them as a weight by econometric methods, the author uses an index number approach to get round the problem.

Time series data for national income and the input factors are converted to index numbers for the base year, then he converts the changes in his series to a percentage of real national income. The input factors are disaggregated into several components, labour disaggregated into employment, hours of work, age-sex compensation, education and white capital disaggregated into inventories, non-residential structures and equipment, dwelling and international assets. When the changes in the quantity of each factor input is known one can then deduce what part of the observed growth in national income is due to an increase in supply of the factors. As distinguished from the part which is due to technological advance, economies of scale, and the many other influences that change output per unit of input.

Denison (1967) in his study of the sources of the growth of national income in the United Kingdom, among other countries, for the period 1950-1962, found the following: real national income grew at an annual rate of 2.29 percent, of which the labour force contributed 0.60 percent. A large part of this contribution was made by the increase in employment (0.50 percent) and the formal education received by the labour force (0.29 percent) while important subtractions were the movement towards shorter hours of work (-0.15) and age-sex composition (-0.04). The capital stock contribution was 0.51 percent to the growth of national income, with increases in non-residential structures and equipment at 0.43 percent, thus making up the largest contribution.

All the contributions of the input factors to the growth of the national product was 1.11 percent. The remaining 1.18 percent of the growth of real national income was due to advances in knowledge (technological change).

This approach has been very popular in the free market countries, since its crucial assumption is satisfied. All those studies assign high contributions to technological advance. Kanamori (1972) for example, found that the contribution of technological advance to Japanese National Income during the period 1955-1968 was around 60 percent.

Chon (1976) in his study on the U.S.S.R. found its contribution to be around 30 percent during the period 1950-1970. Finally Denison (1979) found that the contribution of technological advance in the U.S.A. was somewhere around 39 percent for the period 1950-1962.

4.6 VERDOORN LAW STUDIES

All the literature review is based on the production function, whether it is of the Cobb-Douglas type or of the constant elasticity of substitution, and assumes a constant return to scale. In fact increasing or decreasing return to scale is usually left to appear in the technical change measurement. The reason, according to McCombie (1985), "is, no doubt, largely for well-known pragmatic reasons."

In contrast with those studies which assume a constant return to scale, several others following the pioneer work of Kaldor (1966) have attempted to measure the rate of technical change and the degree of return to scale.* Such studies are based on what is known as "Verdoorn's Law" which is nothing more than the statistical relationship between the rate of growth of productivity and the growth of production† symbolically.

$$TFP = a_1 + b_1 q \qquad (4.43)$$

Where *TFP*, the growth of total factor productivity, is defined as $q - (\alpha L + \beta K)$. The variables q, K, L are the exponential growth rate of output, capital stock and employment, respectively; a_1 and b_1 are the relevant weights of labour and capital and sum to unity; b_1 provides an estimate of $[1-(1-v)]$, where v is the degree of return to scale and a_1 provides an estimate of $(^1/_\lambda)$ where λ is the rate of technical change.

The idea of total factor productivity in these studies is similar to the geometric index of Solow. The underlying structure of equation 4.41 may thus be interpreted as a Cobb-Douglas production function (Bairam, 1987).

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* *For a review of those studies see Bairam (1986).*

† *The original specification of Verdoorn's Law is* $p = a + bq$. *However, other specifications such as* 4.45 *and* 4.46 *are preferable since* p *and* q *can be perfectly correlated in a situation in which* L *is either zero or a constant.*

Since the growth of output appears on both sides of equation 4.43, a specification which circumvents the problem of spurious correlation is,

$$TFI = a_2 + b_2 q \qquad (4.44)$$

Where *TFI* is the growth of total factor inputs, q is growth of output. The coefficient a_2 is the estimate of $(^1/_\lambda)$ and b_2 is an estimate of $(^{-1}/_v)$.

The above specification, i.e. 4.44, of Verdoorn's Law with output growth as the regressor is based on the assumption that growth is essentially demand and not supply constrained and, in the long-run the growth of capital is a function of the growth of output. If on the other hand, the converse assumption is made, namely, that the growth of output is determined by the growth of input factors, the Verdoorn specification is either

$$q = a + bTFI \qquad (4.45)$$

or

$$q = a + b_1 K + b_2 L \qquad (4.46)$$

Where $b_1 + b_2 = \upsilon(\alpha+\beta) = \upsilon$ and $a = \lambda$

These two assumptions have been used by McCombie (1985) in his study on U.S.A. manufacturing industries and by Bairman (1987) in his study on U.S.S.R. manufacturing industries. However, both studies are for two digit industries and not comparable to results such as ours.

The only comparable study is that of McCombie and Ridder (1984) which estimated the growth rate of technical change and the return to scale in the manufacturing sector as a whole, over the period 1963-1973. According to this study technical progress increased by an annual growth rate of around 2.64 percent and the degree of return to scale was around 1.4 percent.

Bairam (1987) in his study on the branches of Soviet industry for the period 1962-1974 estimated seperately the degree of return to scale. This study, in contrast with the normal approach, does not include the return of scale in the measurement of technical change. The base of his model is Verdoorn's Law, which states that the growth of total factor inputs is determined by the growth of output. This hypothesis is based on the assumption that growth is essentially demand and not supply constrained. Symbolically it can be written as

$$TFI = \varphi + \psi q \qquad (4.47)$$

However, Bairman stated that the above equation is not the correct specification with regard to his purpose. "This is because it is widely accepted that industrial growth in the socialist countries of Europe (especially since the early 1960s) in general, and most republics of the Soviet Union in particular, has been essentially supply constrained." He goes on to say "consequently, input growth rather than output growth should be regarded as the independent variables." Thus he estimated the following equations rather than the above equation (4.47)

$$q = \lambda + \alpha L + \beta K \qquad (4.48)$$

$$q = \lambda + v\ TFI \qquad (4.49)$$

Where q and *TFI* growth rates of output and total factor inputs respectively, v is the degree of return to scale and λ is the rate of technical change.

The "total factor inputs specifications (4.49) is a special nest of individual inputs specifications" (4.48), and one can test the validity of the restriction manually, $(\alpha+\beta)=v$. Data used are a series of output, gross capital stock and number persons employed.

For the purpose of estimating equation (4.49) he computed *TFI* as the following:

$$TFI = L^{\alpha} K^{\beta} \qquad (4.50)$$

Where *L* and *K* are indices of gross capital stock and employment respectively and α and β sum to unity.

The result obtained shows that both equations (4.48) and (4.49) give estimates for the rate of technical change and the degree of return to scale which are similar if not identical. Moreover, the rate of technical change was found to vary from 1-2 percent per annum to 6 percent per annum, while the degree of return to scales are found to be in the neighbourhood of 1.

4.7 SPECIFIC STUDIES ON IRAQ

To the best of my knowledge the only study regarding the measurement of technical change in Iraq is that by Fattah (1976), whose work covered the Iraqi manufacturing sector* for the period 1960-1970. Technical change is measured by applying both Kendrick's and Solow's methodologies as follows:

Let A = total factor productivity

Q = output

L = labour inputs

K = capital inputs

Kendrick's measure is:

$$\frac{A_1}{A_0} = \frac{Q_1/Q_2}{\alpha\left[\frac{L_1}{L_0}\right] + \beta\left[\frac{K_1}{K_0}\right]} \qquad \beta = (1 - \alpha) \qquad (4.51)$$

Where α and β are the income shares of labour and capital, and the subscripts 1 and 0 refer to the current and base years respectively.

Solow's Measure is:

$$\frac{dA}{A} = \frac{dQ}{Q} - \left[\alpha\frac{dL}{L} + \beta\frac{dK}{K}\right] \qquad \beta = (1 - \alpha) \qquad (4.52)$$

Where dQ, dL and dK are the time derivatives of Q, L and K and α

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* *The large manufacturing establishment were included.*

and β remain as before.

Data used are series of output, defined as value added gross of labour, defined as an unweighted aggregate of man hours, and capital defined as gross stock of capital available to manufacturing. The weights in combining the factor inputs are the income share of labour and capital in the manufacturing value added.* Capital input is not adjusted for underutilization "despite evidence of its ample existence." Nor are any of the factor input adjusted for changes in quality or composition.

Fattah's final results show that both Kendrick's and Solow's measures of total factor productivity yield negative growth values. More precisely, total factor inputs measured by Kendrick's methodology gives a value of -0.09 as the annual decline of total factor productivity between 1960-1970, while Solow's methodology gives a declining rate of -0.07 percent per annum

The divergence between the results should be expected as input and output growth rates are large, while the negative values are mainly the result of a very high rate of capital accumulations throughout the period.

Fattah's study is subject to certain limitations. First it uses only a 10 year period which is not sufficient to effectively capture

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* *Those shares are 0.39 for labour and 0.61 for capital.*

any technological change which might have occured. Obviously, it includes some years during which the political stability affected economic life in every aspect. Second, and most importantly, the shares used as a weight for the input factors are not the right choice. It is well known that in a socialist country, wages cannot reflect the marginal productivity of labour and thus it is difficult to use this as a share for constructing total factor inputs.

CHAPTER FIVE

THE PRODUCTION FUNCTION AND TECHNICAL CHANGE

5.1 INTRODUCTION

The correct way to analyse the impact of technology transfer is to study such impact. This would be through the measure of technical change which occured over a period in the economy and its various sectors.

Conventionally technical change is defined as a shift in the production function, whereas factor accumulation is identified with a movement along the function. To measure the shift in the function two main problems have been faced by the researchers in this field. The first one is the problem of the accuracy of the specifications of the production function and the second one is specification of the type of technical change.

In specifying a production function for analysing technical change we have different options, using the Cobb-Douglas, constant elasticity of substitution or more recently the transcendental logarithmic (translog) pioneered by Christensen et al (1973). Furthermore, instead of using production functions, recent developments in the duality theory allow the production function to be estimated through its dual, the cost function. In fact no attempt has been made to use this last specification since

> "estimation of cost functions or systems of factor demand equations is preferable in the study of market economics. Those models assume that output prices are proportional to marginal costs and that input prices are proportional to marginal productivities, and that firms are either maximizing profits or minimizing costs. Although profit is an objective of the manager of the firm in the planned socialist countries, it is not the primary goal, and profit cannot be said to be maximized in the same sense as in the market economy" (Whitesell, 1985, see also Cameron, 1981).

In specifying technical change, either neutral or non-neutral technical change may be assumed. However "it has been customary for reasons of theoretical and technical convenience to assume "neutrality" usually in the sense of Hicks or Harrod" (Beckman and Sato, 1969).

In this chapter the most commonly used production functions, viz Cobb-Douglas, and constant elasticity of substitution will be depicted. The way in which they handle technological change will then be described. All this will be discussed in section 5.2. Section 5.3 will be a description of the methodologies used to estimate the rate of technical change that has occured during the period 1960-1978 in the economy as observed in its different sectors. Section 5.4 will be devoted to the estimation procedures and the problems we encounterd and subsequent remedies which were adopted. In section 5.5 an explanation of the sources of growth will be summarized. Finally in section 5.6 the data and the sources will be outlined.

5.2 THE PRODUCTION FUNCTION

The production function is the tool used by econometricians, to express the relationship between the quantity of output and the quantities of the various factors of production required to produce it, and the relationship between the factors of production themselves. It can be presented by a set of isoquants, each representing various combinations of inputs which produce a given output. The further the isoquant is from the origin the larger the output that is assigned to it.

In recent years there has been much debate on the validity of the production function, but as Solow (1957) stated "The aggragate production function is only a little less legitimate concept than, say, the aggregate consumption function and for some kinds of long-run macro models it is almost as indispensable as the latter is for the short run" and it is still acceptable as a "tool of economic theory which has been sharpend by econometric research to a point at which it is highly operational and quite sophisticated" (Yotopoulos, 1976).

In any country and at any time, different technological alternatives are present for producing output, each of which requires a different and appropriate combination of factors of production. The static production function with two factors of production can be written in the form

$$Q = f(K,L) \tag{5.1}$$

where

Q stands for output

K stands for capital

L stands for labour

In order to allow for the quality of labour and capital resulting from technology transfer, to be called technical change, a time variable will be included in the production functions.* Thus equation 5.1 then takes a dynamic form

$$Q = f(K,L,t) \tag{5.2}$$

where t is a time variable (i.e. if cross section data is used rather than time series t = 0).

The relationships between factors of production and output, and between the factors of production themselves, are determined by the existing technology so that it is easy to define both kinds of

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* *It should be noted that excluding the intermediate input from our anslysis is necessitated by the nonavalaibility of such data. In fact some other studies show that technological changes could lead to intermediate input saving (see Desai, 1976 for example).*

technical change, i.e. neutral and non-neutral, in terms of the changes in the production function parameters. Thus both kinds of technical change are manifested in the paramters of the production function as the following:

(1) Neutral technical change might be revealed by a change in the degree of return to scale and for a change in the efficiency of technology (Brown, 1966). The former reflects the effect of that type of technology that deals with the result of the proportionate change in the factors of production on output. While the later deals with that kind of technology that affects only the relation between inputs and output. Both types of technologies have no effect on the relationship between factors of production.

(2) Non-neutral technical change might show up in the degree to which the technology is capital or labour intensive and/or the ease with which capital can be substituted for labour or vice versa. It is obvious that an increase in capital intensity as a result of a new investment of the high quality of capital will result in an increase in total productivity. In general the increase in the intensity of a highly productive factor will result in an increase in the factor productivity.

The ease with which capital is substituted for labour, which is the second source of non-neutral technical change, is measured by the elasticity of substitution; symbolically it can be written as:

$$\sigma = \frac{d(K/L)/(K/L)}{d(F_L/F_K)/(F_L/F_K)} \qquad (5.3)$$

K and L are capital and labour respectively, d stands for a change through time and F_K, F_L are the marginal products of capital and labour respectively. However for σ to be economically meaningfull it must have either the zero or any positive value.

5.2.1 COBB-DOUGLAS

The Cobb-Douglas production function has all along been the most fashionable functional form in the history of econometrics, being widely used in quantifying the relationship between inputs and output*; this form with two factors of production has the following form:

$$Q = A\ L^{\alpha}\ K^{\beta}\ \epsilon^{\mu} \qquad (5.4)$$

where

Q is value added

L is the number of employees

K is capital stock

α and β are the output elasticities of labour and capital respectively.

ϵ^{μ} is a multiplicative error term with $E\mu = 0$, $E\mu^2 = \sigma^2$, $E\mu$

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* *For a survey on studies using this form see Doglus, P. H., "The Cobb-Douglas Once Again Its History, Its Testing and some New Emperical Values", Journal of Political Economy, Vol. 84, October 1976, pp 903-915.*

log L and $E\mu$ log K = 0. This to guarantee that the error term is distributed independently regardless of the input factor level.

The popularity of this form resulted from: First, its computational manageability. Second, Its basic consistency with the established body of economic theory (Heathfield and Wibe, 1987). Third, it offers a direct estimate of return to scale. fourth, the lack of any assumption on the underlying structure. This means that there is no need for the assumption of a competitive pricing system (Uri, 1984). And finally, the changes in the unit measurement have no affect on the parameters except the constant term (Klein, 1965).

Some of the characteristics of the Cobb-Douglas production function are:

First, it is homogenous to the degree of the sum of the elasticities of labour and capital with regard to the output. This is what is called the economy of scale, which might take one of the following forms:

$\alpha + \beta = 1$	constant return to scale
$\alpha + \beta < 1$	decreasing return to scale
$\alpha + \beta > 1$	increasing return to scale

Second, the marginal productivity of the input factors is positive or equal to zero. This is shown by the first derivative of output with regard to the factors of production mathematically as:

$$MP_L = \frac{\partial Q}{\partial L} = A\,\alpha L^{\alpha-1} K^{\beta} \geq 0 \qquad (5.5)$$

$$MP_K = \frac{\partial Q}{\partial K} = \beta \; A \; L^{\alpha} \; K^{\beta-1} > 0 \qquad (5.6)$$

At some point the derivative of the marginal product of output with regard to the inputs are negative as a result of the diminishing return to scale and symbolically this can be written as:

$$\frac{\partial^2 Q}{\partial L^2} = \alpha(\alpha-1) \; A \; L^{\alpha-2} \; K^{\beta} < 0 \qquad (5.7)$$

$$\frac{\partial^2 Q}{\partial K^2} = \beta(\beta-1) \; A \; L^{\alpha} \; K^{\beta-2} < 0 \qquad (5.8)$$

It has a unitary elasticity of substitution as

$$\sigma = \frac{d(L/K)/(L/K)}{d(\alpha L/\beta K)/(\alpha L/\beta K)} \qquad (5.9)$$

Imposing a unitary value for the elasticity of substitution was a result of constant factor shares despite the fluctuation in the factor prices (Douglas, 1948).

5.2.1.1 COBB-DOUGLAS PRODUCTION FUNCTION AND TECHNICAL CHANGE

The Cobb- Douglas function has long been the most commonly used form for measuring technical change. Regarding the two specifications of technical change, i.e. neutral and non-neutral, the Cobb-Douglas handles them as follows:

Firstly, when technical change is of the neutral type it does not change the ratio of the marginal products, labour and capital. As mentioned earlier, this occurs when there is both (a) a change in the efficiency of technology which is expressed in the Cobb-Douglas production function by a change in the constant term, and (b) a change in the return to scale. This can be expressed in terms of change in the degree of homogeneity of the function i.e., $(\alpha + \beta)$.

Secondly, when technical change is of the non-neutral type, it must hence, alter the relationship between the factors of production themselves. So it refers to a change in the elasticity of substitution. A change in capital intensity of technology is expressed by variations in α/β. When this ratio is increased, technical change is "capital saving", otherwise it is "labour saving". Although the movement in the elasticity of substitution can be used to detect the non-neutral technical change, it can-not be used in the Cobb-Douglas world since it always has a unitary elasticity of substitution.

According to the above the Cobb-Douglas production function can capture changes in three of the four characteristics of an abstract technology (Brown, 1966).

5.2.2 CONSTANT ELASTICITY OF SUBSTITUTION

This function was proposed by Dickinson (1954), but was first used by Arrow, Chenery, Minhas and Solow (ACMS 1961). In the last two decades there has been much emphasis on the fact that the elasticity of substitution is not necessarily equal to one as in the

Cobb-Douglas function. Thus there emerged the need for a production function that does not restrict the elasticity of substitution to a certain value since this value in theory ranks from zero to infinity. In this case the Cobb-Douglas function is only a special case of the constant elasticity of the substitution function. The CES has the following form.

$$Q = \gamma \left[\delta K^{-\rho} + (1-\delta)L^{-\rho} \right]^{-\upsilon/\rho} e^{\mu} \qquad (5.10)$$

where $\gamma>0$; $1\geqslant\delta\leqslant0$; $\rho\geqslant -1$; $\upsilon>0$

As before, Q, K, L stand for output, capital and labour respectively.

- γ is the efficiency parameter denoting the efficiency of technology and units of measurement;
- δ the distribution parameter representing capital intensity;
- υ the return to scale or the degree of homogenity of the function;
- ρ the substitution parameter from which we can fined the elasticity of substitution, i.e.,

$$\sigma = \frac{1}{1 + \rho} \qquad (5.11)$$

The popularity of the CES resulted mostly from it being a well behaved function; neutral technical change and the return to scale are each modelled by a single parameter, it can be collapsed to C-D when $\sigma = 1$, and the posibility of finding the value of the elasticity of substitution (Shankar, 1974).

However the original form of the CES can-not be estimated directly since it is not linear in its parameters. Kmenta, (1967, 1971) has managed to approximate the CES to a log linear form by using a Taylor series as follows:

$$\text{Ln } Q = \beta_1 + \beta_2 \text{ Ln } L + \beta_3 \text{ Ln } K + \beta_4 \left\{\text{Ln}\left[\frac{K}{L}\right]\right\}^2 + \mu \qquad (5.12)$$

The parameters of the original function are related to the parameters of Kmenta's approximation in the following manner:

$$\gamma = e^{\beta_1} \qquad (5.13)$$

$$\delta = \frac{\beta_1}{\beta_2 + \beta_3} \qquad (5.14)$$

$$\upsilon = \beta_2 + \beta_3 \qquad (5.15)$$

$$\rho = \frac{-2\ \beta_4\ (\beta_2 + \beta_3)}{\beta_2\beta_3} \qquad (5.16)$$

Equation 5.10 has a degree of return to scale different than one, when it is restricted to one, in which case it will be written as:

$$Q = \gamma \left[\ \delta K^{-\rho} + (1-\delta)L^{-\rho}\right]^{-1/\rho} e^{\mu} \qquad (5.17)$$

The Kmenta approximation to equation 5.17 will be:

$$\text{Ln}\left[\frac{Q}{L}\right] = \text{Ln } \gamma + \delta \text{ Ln}\left[\frac{K}{L}\right] - .5\rho\delta\ (1-\delta)\ \left[\text{Ln}\left[\frac{K}{L}\right]\right]^2 + \mu \qquad (5.18)$$

In 1967 Klein, and Bodkin, succeeded in setting a non-linear estimate to the CES. However this method involved a problem of choosing good initial values. Nadiri (1970), Rosfielde and Lovell, (1977) among others have pointed out the sensitivity of the estimate to the initial values.

5.2.2.1 CONSTANT ELASTICITY OF SUBSTITUTION AND TECHNICAL CHANGE

The CES production function through its parameters has the ability to reveal the different types of technical change which can be investigated by the changes in its parameters and as the following points illustrate:

1. The neutral technical change is denoted by the scale parameter which is reflected in the change in the efficiency of technology as well as the return to scale which shows up in υ. Again both effects have nothing to do with the relationship between the factors of production.

2. The non-neutral technical change appears in two parameters δ, the capital intensity parameter and σ, the elasticity of substitution. A change in δ is non-neutral and an increase in δ will be capital usage, thus resulting in an increase in the marginal rate of substitution of capital for labour. The second paramter, σ , reveals a non-neutral technical change in the elasticity of substitution. This can be clarified by using the results obtained by Diamond, McFadden and Rodriguez, in Fuss et al (1978). Since non-neutral technical change is that type of technology which has a biased effect on the use of the factors of production, it changes the relationships between factors of production and thus the ratio of the marginal product of these factors (Hicks, 1932). Thus the bias of technical change, B , can be defined as:

$$B = \frac{\partial Ln\ MRTS_{KL}}{\partial L} \qquad (5.19)$$

where $MRTS_{KL}$ is the marginal rate of technical substitution between capital and labour. Technical change in the Hicksian range is either capital using (labour saving), neutral, or labour using (capital saving) depending on whether B greater than, less than or equal to zero. Furthermore, since $MRTS_{KL}$ is a function to the ratio of capital and labour, symbolically.

$$MRTS_{KL} = \frac{MP_K}{MP_L} = \frac{\partial Q/\partial K}{\partial Q/\partial L} \qquad (5.20)$$

$$= \frac{\delta}{1-\delta} \left[\frac{L}{K}\right]^{1/\sigma} \qquad (5.21)$$

This shows that Hicksian neutrality is a function of the capital intensity and elasticity of substitution.

5.3. TECHNICAL CHANGE MEASURMENT

In the literature, there are two distinct approaches for measuring the rate of technical change. One is the indirect or the nonparametric approach, which uses the production function as a tool to segregate variations in output due to increases in input factors; and then distinguish the part of output which cannot be explained by the increase in the tangible inputs as a technical change. However, within this approach there are two indices for measuring technical change, i.e. Solow's and Kendrick's indices, both of which assume that the rate of technical change is constant. The two indices are employed to measure technical change on aggregate and sectoral levels. The second method, is the direct or the parametric approach. This is explicity based on making use of the production function and technical change measured as a parameter(s) in the production function. Further, the rate of technical change that is assumed need not be constant as in the first approach, but may take a variety of paths.

All the above specifications define technical change in the same way "to mean any kind of shift in the production function. Thus speed up, improvements in the education of the labour force, and all sorts of things" (Solow, 1957). In other words the kind of technical change we are measuring is a neutral one, which does not change the marginal rate of substitution of capital for labour into a constant capital-labour ratio. In the next section the two approaches of measuring technical change will be discussed in more detail.

5.3.1 INDIRECT APPROACH OF MEASURING TECHNICAL CHANGE

5.3.1.1 SOLOW'S METHOD

Solow in a pioneer work in 1957 used the production to segregate the variations in the output per head due to the technological change from that part due to factors of production. Then he developed a whole time series of technical change and constructed an index called technical change index. His method started by assuming the existence of an aggregate production function of the form,

$$Q = Af(L, K) \quad (5.22)$$

Here Q is the Value added or GNP*, K and L, as defined before, measured in physical units, and A(t) measures the cumulated effect of shift over time.

Differentiating equation (5.22) totally with regard to time and divided through by Q we get:

$$\frac{\dot{Q}}{Q} = \frac{\dot{A}}{A} + A\frac{\partial f}{\partial K}\frac{\dot{K}}{Q} + A\frac{\partial f}{\partial L}\frac{\dot{L}}{Q} \quad (5.23)$$

where a dot indicates time derivatives.

Now assume (1) inputs are paid their marginal products, and (2) the function characterized by constant return to scale, the following relation can be obtained:

$$\frac{\dot{Q}}{Q} = \frac{\dot{A}}{A} + w\dot{L} + r\dot{K} \quad (5.24)$$

where w and r stands for the shares of labour and capital in income.

However, the shares of capital and of labour need not be their

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* *When GDP or value added is used to represent output, the relevant inputs are labour and capital. When gross output is used intermediate input should be included along with labour and capital.*

shares in income. Another alternatives for these shares could be obtained by estimating them using econometric method. The last alternative will be used in this study for constructing Solow's index of technical change. Thus equation 5.24 will be:

$$\frac{\dot{Q}}{Q} = \frac{\dot{A}}{A} + \alpha\dot{L} + (1-\alpha)\dot{K} \qquad (5.25)$$

The ratio of growth of technical change $\dot{A}/A$ can be calculated as a residual from equation (5.25) in the following manner

$$\frac{\dot{A}}{A} = \frac{\dot{Q}}{Q} - \left[\alpha\dot{L} + (1-\alpha)\dot{K}\right] \qquad (5.26)$$

Having estimated the production function coefficients and calculated $\Delta A/A$ as a residual, and by assuming an arbitrary starting value of $A_{(t)} = 100$, then an index of technical change A(t) can be calculated from the relation:

$$A_{(t+1)} = A_t \left[1 + \frac{\Delta A}{A} \right] \qquad (5.27)$$

For the constant elasticity of substitution function, Nelson (1965) demonstrated that the growth rate of technical change is approximately given by:

$$\frac{\dot{A}}{A} = \frac{\dot{Q}}{Q} - \alpha\frac{\dot{L}}{L} - (1-\alpha)\frac{\dot{K}}{K} - \frac{1}{2}\alpha(1-\alpha)\{[\sigma-1]\}\left[\frac{\dot{K}}{K} - \frac{\dot{L}}{L}\right]^2 \quad (5.28)$$

Solow's method has several drawbacks, the first one being that the assumption of constant returns to scale might not be true, and it might lead to an upward or downward bias in the measurement of the rate of growth of technical change. The second one is the assumption of neutral technical change which "is not so easy to accept over a long period of time" (Lave, 1966). Thirdly the specification of the exponential rate of growth of technical change, and fourthly the choice in the production function on whether to include raw materials or not; " including raw materials lead to a smaller index of technical change" (Lave, 1966).

5.3.1.2 KENDRICK'S METHOD

This method is based on the national income accounting technique, so that it is a comparison between the output and factors of production, after weighting them (Kendrick, 1961). The weight of the factors of production is usually their shares in the national income, i.e. wages for labour and profit for capital.

In general the income identity can be written as:

$$Q = w\,L + r\,K \quad (5.29)$$

Where Q is output, w is wages, r is profit, L is labour and K is capital. Holding w and r fixed and in expressing equation (5.29) with growth rates we get:

$$\frac{Q_1}{Q_0} = w_0 \frac{L_1}{L_0} \quad r_0 \frac{K_1}{K_0} \tag{5.30}$$

But usually the growth of the output is greater than that of the factors of production weighted by their share in the output. The difference caused by increasing efficiency or technical change, necessitates the inclusion of an additional factor, say C_0, into equation (5.30). The index C_0 would reflect technical change, since it expresses growth in production in relation to growth of the production's factors.

Thus equation (5.30) in its final form should be written as follows:

$$\frac{Q_1}{Q_0} = C_0 \left[w_0 \frac{L_1}{L_0} + r_0 \frac{K_1}{K_0} \right] \tag{5.31}$$

and rearranged gives:

$$C_0 = \frac{\frac{Q_1}{Q_0}}{\left[w_0 \frac{L_1}{L_0} + r_0 \frac{K_1}{K_0} \right]} \tag{5.32}$$

Which is the arithmetic technical change index.

When the production function is CES rather than C-D, the index might be written as:

$$C_0 = \frac{\frac{Q_1}{Q_0}}{\left[\delta\left[\frac{K_1}{K_0}\right]^{-\rho} + (1-\delta)\left[\frac{L_1}{L_0}\right]^{-\rho}\right]^{-1/\rho}} \qquad (5.33)$$

This index is not without its own defects, first of all the assumption that wages and profits are changed only by technical change, "over a short period of time, assuming that prices are affected only by technological change might be a reasonable approximation, although over a longer period it clearly is not" (Lave, 1966). Secondly, the substraction of the cost of raw materials from output and excluding it from the production inputs increases the index when C > 1 and reduces it when C < 1 and thus increases the absolute rate of growth of the index. However on the national level the problem almost disappears because the consolidation of industries obviously eliminates their input-output relationship, with imports from other countries being the only exception (Domar, 1962). Even so this index defects from what we have mentioned above and as Domar (1962) stated: "the simplicity of this approach has many advantages that aid understanding and exposition"

Note that the weights will be used in this study as they would be in constructing the Solow's index.

5.3.2 DIRECT APPROACH OF MEASURING TECHNICAL CHANGE

This approach, just as the previous one, is based on the assumption of an existing production function. The time trend is included as an explanatory variable in the function in order to give a direct estimate as to the rate of growth of the neutral technical change. For the purpose of this study three alternative specifications of technical change are identified:

$e^{\lambda_1 t}$	constant growth of technical change
$e^{\lambda_1 t + \lambda_2 t^2}$	variable and continuous growth of technical change
$e^{\lambda_1 t + \lambda_2 D}$	variable and discrete rate growth of technical change (where D is a dummy variable taking a value of 0 for the period 1960-1972 and 1 for the period 1973-1978).*

With regard to the variable growth specifications further developments have been attempted, such as that by Weitzman (1970) who used t^2 in an effort to test for a systematic decrease or increase in the rate of growth of technical change. Also Kemme (1987) used a dummy variable instead of t^2 and according to him "including t^2 in the equation may not capture a rather discrete shift since it allows for a continuous accelerating change in joint factor productivity over the entire sample period".

After introducing the above specifications of technical change to

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* *This distinction is made based on the fact that after 1972 and as a result of the oil nationalization and the increase in oil prices. Iraq has transferred a massive amount of highly advanced technology, thus one might correctly assume that a high rate of technical change might be accomblished during this period.*

the two forms of production function we get the following functions:

- Constant elasticity of substitution with constant growth of technical change

$$Q = \gamma \, e^{\lambda_1 t}[\delta K^{-\rho} + (1-\delta)L^{-\rho}]^{-1/\rho} \qquad (5.34)$$

- Constant elasticity of substitution with variable and continuous growth of technical change

$$Q = \gamma \, e^{\lambda_1 t+\lambda_2 t^2} \, [\delta K^{-\rho} + (1-\delta)L^{-\rho}]^{-1/\rho} \qquad (5.35)$$

- Constant elasticity of substitution with variable and discrete growth of technical change

$$Q = \gamma \, e^{\lambda_1 t+\lambda_2 D} \, [\delta K^{-\rho} + (1-\delta)L^{-\rho}]^{-1/\rho} \qquad (5.36)$$

- Cobb-Douglas with constant growth of technical change

$$Q = A \, e^{\lambda t} \, K^{\alpha} \, L^{(1-\alpha)} \qquad (5.37)$$

- Cobb-Douglas with variable and continuous growth of technical change

$$Q = A \, e^{\lambda_1 t+\lambda_2 t^2} \, K^{\alpha} \, L^{(1-\alpha)} \qquad (5.38)$$

- Cobb-Douglas with variable and discrete growth of technical change

$$Q = A \, e^{\lambda_1 t+\lambda_2 D} \, K^{\alpha} \, L^{(1-\alpha)} \qquad (5.39)$$

In finding which specification of the production function is more appropriate the CES would be rejected in favour of the C-D only if the estimated results are meaningless from an economic theory and statistical test point of view. According to Bairam, 1986_a and

Yotopoulos, 1967 there are many criteria according to which such discrimination can be made:

- Using statistical tests.
- Economic restrictions.
- Logic of the mechanics of the production process.
- computational manageability.

To discriminate between the above equations we have used the following criterion; starting with CES, which is more general than C-D, and it can collapse to the latter when $\sigma=1$, where $\sigma=1/(1+\rho)$, we tested whether the estimated value of σ is significant; when σ is found to be significant and the equation satisfied the following restrictions: $0<\delta<1$ and $\rho>-1$, then we assume that the best function to describe the production process is the CES.

To discriminate between the three specifications - 5.34, 5.35 and 5.36 - we first chose one of the two variables of growth of technical change, i.e. equations 5.35 and 5.36. In doing so we compared their coefficients of determination, (R^2), values which is a reasonable test since they both have the same number of parameters (Mizon, 1977). Second for discrimination of the preferred specification and that of constant growth of technical change equation 5.34, the percentage increase in the sum squares of the residual corrected for degrees of freedom is used. This will be described as the F statistic with r and h-m degrees of freedom (Weitzman, 1970). This test can be applied as follows:

$$F = \frac{(SSE_{res} - SSE_{unr})/r}{SSE_{unr}/(h-m)} \qquad (5.40)$$

Where SSE is the sum squares of the residual, m is the number of parameters in the unrestricted model, r is the number of restrictions to be tested, h is the number of observations and subscripts *res*, and *unr* denote the restricted and unrestricted hypotheses. If non of the three specifications satisfy the above restrictions we assume that C-D function is the one underlying the production structure. The same procedures are followed for a matter of discrimination between specifications 5.37 to 5.38 when the C-D found to the best fitted specification.

5.4. ESTIMATION PROCEDURES

The technique used in estimated equations 5.34 to 5.36 is a non-linear technique available in the Time Series Processor (TSP). However,"it is well known that the parameters estimate obtained by this method may not be insensitive to the initial guesses used to start the non-linear program in motion" (Rosefielde and Lovell, 1977). To overcome this problem those equations were transferred to their linear approximations and were estimated by the ordinary least squares method. As a consequence the approximations are now:

$$\mathrm{Ln}\left[\frac{Q}{L}\right] = \mathrm{Ln}\,\gamma + \lambda t + \delta\,\mathrm{Ln}\left[\frac{K}{L}\right] - .5\rho\delta\,(1-\delta)\,\left[\mathrm{Ln}\left[\frac{K}{L}\right]\right]^2 \qquad (5.41)$$

$$\mathrm{Ln}\left[\frac{Q}{L}\right] = \mathrm{Ln}\gamma + \lambda_1 t + \lambda_2 t^2 + \delta\,\mathrm{Ln}\left[\frac{K}{L}\right] - .5\rho\delta\,(1-\delta)\,\left[\mathrm{Ln}\left[\frac{K}{L}\right]\right]^2 \qquad (5.42)$$

$$Ln\left[\frac{Q}{L}\right] = Ln\gamma + \lambda_1 t + \lambda_2 D + \delta\ Ln\left[\frac{K}{L}\right] - .5\rho\delta\ (1-\delta)\ \left[Ln\left[\frac{K}{L}\right]\right]^2 \qquad (5.43)$$

Parameter estimates obtained from equations 5.41 to 5.43 are then used as initial guesses in equations 5.34 to 5.36

The criteria which the non-linear estimate is based on in estimating the coefficient's values is the same as that of a linear estimate. This criteria is to minimize the sum of the square residual. In their general form, equations (5.34, 3.35 and 5.36) might be written as follows:

$$Y_t = f(x\ ,\beta) + \epsilon_t \qquad t=1,\ldots\ldots,T \qquad (5.44)$$

where

Y is an endongenous variable.

x is a vector of explanatory variables.

β is a vector of parameters to be estimated.

The problem is to find a set of $\beta = (\beta_1, \beta_2 \ldots\ldots \beta_n)$ which minimizes the sum of the square of the residual in equation form,

$$\sum_{t=1}^{T} (y-f(x,\beta))^2 \qquad (5.45)$$

The time series process estimates a vector of β in the following manner: first it has used the initial values of the parameters in the iteration of i as a parameter of values, β_i (i-1). It is used to compute the direction vector d. So its first series would be.

$$\beta_i = \beta(i-1) + d \qquad (5.46)$$

If the sum of the square residual of this iteration is less than that of the previous one, the new value replaces one of those currently used.*

Furthermore, when estimating the C-D form the Ordinary Least Squares method is used to obtain the parameters, but in most of the cases we specified an autocorrelation by the low value of Durbin-Watson statistic, so that other methods were used. However the presence of autocorrelation between the error terms may be due to: (a) incorrect specification of the function or (b) incorrectly excluding some important variable or (c) the possibility of successive observations likely to be interdependent in the time series due to business cycles (Intriligator, 1978).

As a treatment for this problem there are many methods, such as the use of a log of the dependent variable as an explanatory variable, or using the first differences between the observations instead of its absolute values, or the use of an autoregressive model. In our case we tried all the three possibilities and the best estimate is used.

Another important problem that has been faced in our estimation is the multicolinearity. This problem is not exceptional, but is a typical phenomenon in production function studies and stems from the

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See for more details TSP, Version 3.5 users manual.

parallel change in capital stock and employment.* However, three solutions might be found to this problem; the first is reducing the number of the independent variables by dividing the remainder by the one to be omitted. The second uses the first differences, and the third drops one of the variables. In our case the first two methods can be used and the first method has one advantage over the second one, in that it does not reduce the number of observations. Estimated multicolinearity between the log of the two independent variables as is shown by the simple correlation coefficient are presented in table (A.7 in appendix A).

Another problem deserves to be mentioned: that is, the strange behaviour of labour input figures in some sectors, especially in the period prior to 1968. For example the labour force figures in the manufacturing sector did not increase even by a single worker during the period 1960-1964. This might result in assigning a low share for labour and consequently a higher share for capital.

5.5. EXPLANATION OF ECONOMIC GROWTH

By adopting the best estimate obtained by the direct approach in the previous section, we can now identify the contribution that

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* *see for example Mohamed-Ahmed 1979, Ballassa, B., and Bertrand, T., 1970, Dholakia 1976, Nasilowski, M., 1981.*

technical change has made to the economic growth on aggregate and sectoral levels. In addition to that contributions made by the conventional inputs, viz, labour and capital will be identified as well as that of total factor inputs (TFI). This will be done with the help of the following equation:

$$g_Q^{est} = g_A + \eta_K gK + \eta_L gL \qquad (5.47)$$

where g_Q^{est} = estimated rate of growth of output

g_A = rate of growth of technical change

g_K = rate of growth of capital input

g_L = rate of growth of labour input

η_K and η_L are the output elasticities with respect to capital and labour respectively.

According to equation 5.47 growth rate of output is a result of growth rate of technical change and that of factors of production. Thus if, for example, there is a decline in the rate of growth of output, this might be attributed to a decline in the growth rate of technical change and/or to a decline in the rate of growth of factor inputs.

However, the shares of capital and of labour, η_K and η_L, are egual to α and β when the underlying production function is of C-D form, further those shares are constant over time. Moreover those shares are no longer assumed to be constant when the function is of CES form.

According to Weitzman (1970) with the CES production function and constant growth rate of technical change these shares are:

$$\eta(t)_K = \frac{K \frac{\partial Q}{\partial K}}{Q} = \delta \Upsilon^{-\rho} e^{-\lambda \rho t} \left[\frac{Q(t)}{K(t)}\right]^{\rho} \qquad (5.48)$$

$$\eta(t)_L = \frac{L \frac{\partial Q}{\partial L}}{Q} = (1-\delta) \Upsilon^{-\rho} e^{-\lambda \rho t} \left[\frac{Q(t)}{L(t)}\right]^{\rho} \qquad (5.49)$$

However the sources of growth will be identified as follow: First we constructed the imputed shares of the factors of production, if the selected equation is of CES form then those shares would be constructed according to equations 5.48 and 5.49. If the selected equation is of C-D form rather than CES α and $(1-\alpha)$ would be used as a shares. Second, by combining those shares with the growth rates of the factors of production and then by adding the contribution of technical change the estimated growth rate of output will be obtained. However, a slight departure from the normal approach is taken, that is the way used in estimating the growth rates of the variables. In fact, there are different methods which could be used for this purpose. An annual average rate can be calculated by comparing the values of the variables in the base and the end years. Alternatively, it would be possible to calculate the rate of growth in every year and take the average as the representative rate of growth during the period under consideration.

However none of the above methods can be considered satisfactory as they imply a comparison of two points in time and ignore any changes of the variables during the intervening years. It is quite possible that Iraq had several recessions and/or booms during the period studied, but the above methods would have completely failed to grasp any such possible changes. Furthermore, the condition of the economy during the beginning year and the end year might introduce another source of bias for our estimation (Al-Eyed, 1979).

For the above reasons we decided to choose the ordinary least squares method. This method is assumed to pick the growth rate over time that best fits with all of the varying annual growth rates, rather than the growth rate between two points in time.

Having specified the rate of growth of technical change and estimated the production function forms, we may then pass on to simulate the output levels generated in the economy as a whole as well as its different sectors. This will give an idea on how much closely estimated output levels originating approximates its observed value over the period 1960-1978. Then we will go a step further and project the role played by technical change and other factors of production for the period 1979-1990. This exercise becomes plausible since the estimated equations succeeded in simulating output levels rather well in most of the sectors as well as the economy.

For projection purposes we find that the assumption of the magnitude of (labour's and capital's) the growth rate of labour and capital do not affect the projected contribution of technical change to output significantly. In spite of that our projection will be carried out with assuming that capital and labour are growing in the same rates as that of the period 1973-1978. At the same time we will show how much the role played by technical change would be affected if we assume that labour and capital are growing by half of their rates during the period 1983-1988 which is affected most by the war.

5.6 DATA AND SOURCES

The data used in this study are time series of sectoral real value added, real gross capital and labour (number of persons employed). Those series are not readily available in the required form, so we therefore have to construct them. Constructing these series is not an easy task even for the developed countries. The problem becomes even more difficult where the developing countries are concerned. As Bruton (1968) stated: "data in this field are always inadequate and incomplete but this fact is not a sufficient reason for ignoring them".

Ideally the proper measure of the factors of production should be their services, or that part actually utilized, rather than resources at hand (Walter, 1963). However, measuring the services of the factors of production as one of the many economic concepts, by its very nature, cannot be easily defined and precisely measured.

Measuring that part actually utilized has been a difficult problem especially when the variable under consideration is capital stock. Solow (1957) used the rate of unemployment for adjusting his capital stock. Some others adjusted their capital stock according to the energy consumption.

The choice of the period under study is mainly dictated by the availability of the data. The Year 1969 has been chosen as the base year in our series of value-added and capital stock, for two reasons. Firstly, it is in the middle of the period under study, and secondly it is characterized by a low rate of inflation. The inflation rate has since started to increase to a higer rate in 1970 and thereafter. According to Al-Eyed (1979), the average inflation rate for the period 1960-1969 was as low as 1 percent and it increased to 7 percent in the year 1970, as a result of the increase in the price of oil during the last quarter of that year.

Since the estimated technical change magnitude depends mainly on the data used, we feel that the method and the sources used in constructing the series of output, labour and especially capital stock deserve further discussion.

1.Value-Added

Annual figures on value-added for Iraq are available back to 1953. Those figures were estimated by Haseeb, (1959) for the period 1953-1956. Later he extended his estimate to cover the period up to

1959. Another attempt was made by Kanaan, (1966) covering the period 1960-1963. Officially some attempts have been made by the Ministry of Planning.

For the purpose of our study we constructed a series of real value-added for the seven sectors. Then the sum of those figures is the value-added series of the whole economy.

The annual abstract of the statistics published by the Ministry of Planning also provides a series on value-added output for the seven sectors in both current prices as well as in constant price up to 1974. The figures for the years 1975 and 1976 are further aggregated into three sectors. i.e. Commodity, Service and Distribution sectors. For the later years, since 1977, the figures can be found in the annual abstract of statistics, to the same required level of disaggregation but they are in current prices only. The constant price figures for those years since 1975, that are not available, are based on estimates made by Abdul- Amir, (1979) and which were subsequently published by the Ministry of Planning.

The series with constant prices have three different base years so that we have to convert them in one common base which is 1969. For this purpose an implicit price deflator for the seven sectors has been constructed (see table A.2 in appendix A) and used for deflating the nominal series of value added.

2. Labour Force

As mentioned earlier, figures on factors of production used in the production function studies should reflect the services supplied by these factors rather than the existing amount of those factors. According to Klein (1965) and many others, a series of man-hours is a suitable measure for labour input. However this argument has been criticised on the ground that labour input is not homogenous, neither within firms nor across industries or over years. The measurement of labour by using man-hours or related measures is thus not satisfactory as pointed out by Nadiri (1970). If we assume that perfect competition exist and factors of production are paid their marginal productivity, then wages could be used to represent labour.

However, in our case, the data available on the labour force within the Iraqi economy and its differnt sectors is very limited and hardly usable. In fact most of the data in this field is based on estimates and is inaccurate (Sultan, 1986; Samara, 1981; Ahmed, 1978). However the most consistant estimate of labour force for the period 1960-1973 is the one by Nelstorm, a U-N manpower expert. We know that his figures are adopted by the Ministry of Planning as the official figures on the Iraqi labour force, since they appear in the CSO publication. Thus his figures are used in this study on aggregate and sectoral levels. Figures for the years 1974 to 1978 are taken from different sources.

For the aggregate level figures on the labour force are accessible in various publications of the Minnistry of planning. For some sectors, namely manufacturing, construction, electricy, gas and water, there are official figures, on both the number of persons employed as well as wages paid, since 1960.* Figures on the labour force in the mining and quarrying sector and distribution sector are extracted from Ahmed (1978). For figures on services and agricultural labour force we make use of the series constructed by Samara (1981), since those figures were derived with the help of manpower experts in the Ministry of Planning.

In addition to those sources we make use of some other publications such as that of ACWA and the Food and Agriculture Organization.

We made no attempt to use wages instead of the number of persons employed. The reason for not using wages is that in the socialist countries the labour force is not necessarily paid its marginal productivity, so that the marginal productivity law would be broken (Dhrymes, 1974).

3. Capital Stock

For most studies, especially those concerning developing countries, the construction of a capital stock series presents special problems. Before we proceed further we define what we mean by capital, and then

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* *For the manufacturing sector the figure of 1960 covered the large esatblishments only. This is because the survey on small establishments only started in 1961.*

discuss briefly some of the concepts frequently mentioned in this context.

The term capital might be defined as: goods which yield no immediate utility but are used to produce goods which do (Thirlwall, 1983). This should not be confused with the capital concept used by the businessman or accountant, to refer to the flow of funds.

With regard to the measurement of capital stock, two important problems deserve to be mentioned. First the concept of capital is by its very nature difficult to identify and quantify. Second, the unavailability of data frequently leads to a proxy measurement which does not properly reflect the reality of what it is attempting to describe.

For our purpose it is necessary to distinguish between the following concepts and their alternatives with regard to the production function related analysis.

The first concept is gross capital and its alternative is net capital. In general net capital is nothing but gross capital after depreciation has been subtracted. This is the same as saying that the machinery's value tends to fall as time goes by. Solow (1957), Ward (1975) among others argued that the efficiency of machines or buildings does not decline over time. Kendrick (1961) favours the net stock concept; he believes that "Real stock of accumulated depreciation allowances are taken as a latter measure of basic capacity to contribute to production and revenue than gross stock (i.e the number of items in use each weighted by base-period price regardless of age). Studies have shown that the gross output capacity of various types of machinery tends to fall with age, and the repair and maintenance charges rise so that the contribution to net revenue falls even more. More significantly, the marginal revenue products of older types of equipment are less than those of new, improved types because of technological advance and resulting obsolescence....The effect on the real marginal revenue product of groups of items over time is roughly approximated by the gradual decline in the depreciated real value of stock shown by the usual depreciation accounting procedures reflected in national accounts"

The second concept is stock of capital or flow of capital. The former refers to the total value of existing assets while the later refers to that part of stock actually utilized in the production process. However, adjustment to the rate of utilization can be measured by using the variation of unemployment as a proxy variable, or by using the direct production energy consumption. We feel that both methods are not suitable for our study. The unemployment rate cannot be used since Iraq is a socialist country and full employment its therefore one of its aims, and a characteristic at least since 1974.* While using electricity consumption is not possible due to lack of data.

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* *The revolutionary command council deceided with its resolution No. 103 of the Feb 7th,1974, to appoint all the unemployed college and institute graduates at the state departments.*

In constructing our capital stock series we employ the perpetual inventory method pioneered by Garland and Goldsmith (1959). This method is an accumulation of the past capital formation mathmatically expressed as:

$$K_t = \Sigma K_{t-1} \cdot (1-d) + I_t \qquad (5.50)$$

where K_t is capital stock at year t

I_t is gross investment at year t

d is the depreciation rate

When the series required is a gross capital stock rather than net capital, d is replaced by zero.

The main difficulty with this method lies in getting it started, in other words how to find the benchmark year estimate (Clark, 1970). According to this method, capital stock in the first year is assumed to be equal to zero. Consequently, the capital stock figures will be subject to a downward bias, unless the figures on capital formation can be extended back for a long enough period of time. This can be done in those developed countries where there are figures that go back numerous decades.*

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* *e.g. In Denmark, for constructing capital stock series,the industries' series of capital formation extends back to the year 1905, as has been used by Groles (1976), compare to this the Australian series which goes back to the year 1863 and in the case of Norway to 1865 (Clark, 1970).*

Iraq as most other developing countries does not have a series of capital formation extending back far enough. To get round this problem, following Al-Dhawi (1982), we used the concept of the capital-output ratio to determine a base year for capital stock i.e.

$$K_t = k \cdot Q_t \tag{5.51}$$

where

$$k = K/Q \tag{5.52}$$

where K is capital stock

and Q is value-added

For estimating equation 5.52, an average series of capital formation and value added for real terms for the period 1953-1959 have been used. We did so because the year 1953 was the earliest year for which figures on the capital formation at sectorial level are available.* For the purpose of constructing a series of the capital formation in real terms we constructed sectorial implicit price delfators. For this we used a series of capital formations in nominal terms as well as in series with the different base years. First we converted the constant series to one base year, which is 1969, then we deflated the nominal series. However all the figures used are from the Iraqi Ministry of Planning publications.

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* *An earlier attempt was made by Abu-El-Haj, R (1961) but we could not use his figures because they are highly aggregated.*

CHAPTER SIX

TECHNICAL CHANGE ESTIMATE

6.1. INTRODUCTION

In this chapter we investigate the impact of technology transfer on Iraqi's economic development in aggregate and at sectoral levels, during the period 1960-1978. The data used are series of value-added, numbers employed, and net capital stock.

Methodologies used for this purpose are both the indirect and direct methods, as described in the previous chapter. The indirect method will contain the estimates of Solow's and Kendrick's indices. The direct method involves direct estimate of the two functional forms after introducing the two specifications of technical change i.e. constant and variable rates of growth specifications. Furthermore the last specification will be practised within two approaches, the first one is that including t^2 in the production function in order to capture a continuous acceleration or deceleration of technical change as occured during the period from 1973 onwards. The second one is the dummy variable approach which might be an appropriate specification to capture a discrete change in the growth rate of technical change as occured during the period, in which we expected to experience a variable rather than a constant growth rate of technical change.

6.2. ESTIMATION RESULTS

For constructing Solow's and Kendrick's indices the two functional forms adopted in this thesis i.e. CES and C-D will be estimated in order to find the relative shares of capital and labour. We start with the CES function which is more general than the C-D function. The criteria used for discriminating between the two forms is to test wither σ, the elasticity of substitution, is significant or not. When σ is found to be significant we assume that CES is the better form underlying the production process and thus Solow's and Kendrick's indices are constructed according to equations (5.28) and (5.33) respectively. If σ is found to be insignificant the CES would be rejected in favor of C-D and thus equation (5.26) is used for constructing Solow's index and equation (5.32) is used for constructing Kendrick's index. The results of estimating the two functional forms are reported in table A.8 and A.9 in appendix A.

In the following sections the estimation results of technical change for the economy and its sectors will be presented.

6.2.1. The Whole Economy

After 1953 oil revenue begun to play an ever increasing role in Iraq's economic development, first because of the half sharing agreement and secondly the near total nationalization of the oil industry by 1972, just in time for the third vital factor, the oil price boom of 1973. This importance is amplified in figures as follows: between 1953 and 1970 oil revenue amounted to an average to 33 percent of nominal GDP whereas by 1975 (i.e. after the price increas) it almost doubled in magnitude to nearly 60 per cent.

Iraq in its thirst for modernaization with an admirable financial situation has transferred a massive amount of modern technology in order to built the required scientific and technological base for inhancing technological changes.

The estimation of technical change that occured in the economy during the period 1960-1978 can be made through using either the indirect method, as applied in our case by both Solow's and Kendrick's methods, or the direct method. Both shall be analysed below.

1. Indirect Estimate

During the period under consideration, the Iraqi gross domestic product was growing at rate of 7.76 per cent per annum. As shown in table B.5 in appendix B, the total factor inputs was increasing at a rate of 6.54 per cent during the same period. Thus there is 15.7 per cent of the growth of the gross domestic product is not accounted for by the increase in the input factors, viz. labour and capital.

The calculation of Solow's index of technical change for the economy is presented in table (6.1) and figure (6.1). The index shows an increasing trend for the overall period. In fact its overall growth rate amounted to 55.5 per cent. Stated in a different way, the production function shifted upward about 1.81 per cent per year during that period.

For individual years the largest decline happened during 1963, 1967, 1970–1972. The decline in 1963 might be attributed to the intensive battle in the North of Iraq and political instability. Further battles though this time on an international scale, namely the Arab–Israeli War, probably attributed to the decline during 1967. Finally the decline during the period 1970–1972 was due to the conflict between the government and the foreign oil companies as caused by the desperate decline in oil production and thus revenue.

It might of interest to study the behavior of the index for different subperiods and highlight the reasons behind the movements. For the 1960–1967 subperiod the index had a downward trend, it declined by 6.71 per cent overall the period and by 0.99 per cent per annum*. This decline might be attributed to:

1. The low absorption of technology transfer was due to the late start of development. In fact Iraq started its development after 1953, following the profit sharing agreement between the government and the foreign oil companies. As supported by Gomulka's (1971) argument, that the rate of growth of

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* *All growth rates of the variables are calculated by using the OLS method (see appendices). When those rates are not obtainable by the OLS they are then calculated as a acomparison between the values of the* variables *in the base and end years,* unless otherwise indicated.

TABLE 6.1.

Solow's index of technical change for the Whole Economy, 1960-1978.

year (1)	ΔQ/Q (2)	ΔL/L (3)	ΔK/K (4)	ΔTFI (5)	ΔA/A (6)	Solow's index (7)
1960						100.000
1961	11.5671	4.39457	14.2154	8.27704	3.29006	103.290
1962	5.70819	3.47305	13.9004	7.59529	-1.88710	101.341
1963	-1.59627	3.42014	10.6259	6.26878	-7.86505	93.3704
1964	15.8733	3.64837	8.37315	5.51621	10.3570	103.041
1965	13.6239	7.18026	8.52282	7.71101	5.91293	109.133
1966	4.00690	6.13006	8.39510	7.02549	-3.01859	105.839
1967	-5.73908	4.44234	8.68508	6.11962	-11.8587	93.2880
1968	15.5717	5.58030	7.32563	6.27028	9.30144	101.965
1969	2.43700	3.41741	6.57761	4.66673	-2.22973	99.6916
1970	1.26160	4.32412	6.75340	5.28449	-4.02289	95.6811
1971	6.06924	3.42682	7.33677	4.97254	1.09670	96.7304
1972	3.23853	3.21685	6.97374	4.70206	-1.46353	95.3148
1973	10.5242	3.17638	7.24825	4.78612	5.73806	100.784
1974	10.2279	-4.24484	9.24451	1.08790	9.14004	109.996
1975	27.5565	11.2717	12.0231	11.5687	15.9878	127.582
1976	14.5330	0.69345	17.2217	7.22755	7.30545	136.902
1977	11.9218	2.36311	16.1974	7.83223	4.08960	142.501
1978	16.6204	4.17189	12.2575	7.36836	9.25207	155.501

Notes: In this and the following similar tables: Q = value-added, L = labour input, K = capital input, TFI = total factor input calculated as $(\alpha L+(1-\alpha)K)$, α and $(1-\alpha)$ = shares of labour and capital respectively.

$$\frac{\Delta A}{A} = \frac{\Delta Q/Q}{Q} - \alpha \frac{\Delta L}{L} - (1-\alpha) \frac{\Delta K}{K}$$

Sources: Tables A.9 and B.1.

Figure 6.1 Solow's and Kendrick's Indices of Technical Change for the Whole Economy 1960-1978

Sources: Tables 6.1 and 6.2

productivity and output are higher the more backward the country is, low absorption resulted in a high decline in capital productivity which fell by 2.99 per cent per annum during this subperiod. Furthermore, according to the author this means that such a country is able to reap the benefits from the diffusion of technology from the more advanced countries.

2. The scarcity of skills on different levels, as a result of the lack of eduction and training also features. The importance of eduction has long been recognized, Denison (1974) summarized this importance as "a sharp upward shift in the educational background of the American labour force has upgraded skills and versatility of labour and contributed to the rise in national income". In addition to that the reversal of technology transfer or the so called "brain drain" has also had a major impact on Iraq. It is estimated that around 3000 high level scientists and engineers and technologists have settled abroad (UNCTAD, 1978_a). It is worth mentioning here that Iraq has provided special incentives for its high-level personnel living abroad inducing them to return.*

3. Of course social, cultural and political factors are also contributed to the decline. In general these factors can either

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* *In 1970 law No. 189 was issued but due to it being ineffectual it was replaced by law No. 154 in 1974. This was to encourage Iraqi ex-patriots to return with the following incentives being granted: travelling expenses, removal expenses, custom duty exemption on importing belongings, provision of cheap land and an interst-free loan (see progress under planning, 1975).*

promote or be an obstacle in the growth process. Customs, religious beliefs and the attitude to work etc, all have something to do with productivity. However in Iraq all of those factors contributed negatively in some way or another during this specific subperiod and were therefore another reason for the decline in productivity. Despite this the political factor proved to be one of the most significant factors which hindered the development impact of technology transfer and its agent technical change, during this specific subperiod.

During the 1968-1972 subperiod the index continued to decline and this time at a rate of 1.64 per cent per annum. The poor performance of the index during this subperiod might be attributed to the following:

1. Since this index describes the general condition of all the sectors, it must be affected by the performance of every individual sectors. The sharp decline in the total factor productivity in the mining and quarrying sector in the period before the oil nationalization has had a large impact on the performance of the index of the economy.

2. Shortages in the skill profile lessen the assimilation of the transferred technology.

For the subperiod 1973-1978 Solow's technical change index increased substantially in comparison with the previous subperiods; it rose at an annual growth rate of around 9.0 per cent, being 54.3

per cent for the whole subperiod. This high performance might be attributed to

1. The high investment which took place after the success of the oil nationalization in 1972 and the subsequent oil price increases. In fact new investment in Iraq, which is mostly in the form of imported technology, does not serve to deepen the per worker capita but also serves as a carriers of technical progress. Furthermore the adopted turn-key strategy fastened the economic development by overcoming the implementation problems which require highly skilled designers, engineers, etc.

2. The rapid improvement in the country's skilled labour force resulted in a sharp increase in labour productivity. This reflects a high absorption of the new technololgy. Labour productivity increased by 12.9 per cent per annum which is mainly due to the increase in capital intensity. Data on the capital-labour ratio shows that it grew by 10.4 per cent per annum during this last subperiod.

Kendrick's index of technical change is presented in table (6.2) and is also drawn in figure (6.1). This index shows the same movement as that of Solow's.

The increase in the rate of technical change according to this index is lower than that obtained by Solow's methodology. The annual growth rate of the index for the entire period is 1.14 per cent compared to 1.81 per cent in table 6.1. In fact the result obtained

TABLE 6.2.

Kendrick's index of technical change for the Whole Economy, 1960-1978.

year (1)	output (2)	T.F.I (3)	Kendrick's index (4)
1960	100.000	100.000	100.000
1961	111.567	108.277	103.096
1962	117.936	116.746	101.019
1963	116.053	124.445	93.2568
1964	134.474	131.673	102.128
1965	152.795	141.955	107.636
1966	158.917	152.173	104.432
1967	149.797	162.010	92.4617
1968	173.123	172.426	100.404
1969	177.342	180.993	97.9831
1970	179.579	191.009	94.0160
1971	190.478	201.319	94.6155
1972	196.647	211.676	92.9000
1973	217.343	222.900	97.5066
1974	239.572	229.429	104.421
1975	305.590	256.262	119.249
1976	350.002	282.016	124.107
1977	391.728	312.205	125.471
1978	456.835	341.206	133.888

Notes: In this table and the following similar tables (1) T.F.I stand for total factor inputs calculated as ($\alpha L + (1-\alpha)K$), (2) The method of calculation of the index has been discussed in detail in section 5.3.1.2, and (3) all figures are in percentages.

Sources: Tables A.9 and B.1.

by these indices should be very close when the annual growth rates of labour and capital are not very large (Domar, 1962). However this is not the case here.

2. Direct Estimate

The best estimate of the growth rate of technical change can be found by using the direct method; is presented in table (6.3). It is clear from the table that the best specification of growth of technical change is obtained by assuming technical change growing by a continous and increasing rate. In fact this specification along with capital and labour have succeeded in axplaining more than 96 per cent of the variations of output (in Ln). Thus it can be said that this equation fitted our data very well from a statistical point of view. Moreover, when this equation used for simulating output levels for the period understudy very close figures were qchieved (see table B.3 and figure B.1 in appendix B)

Adopting this specification of technical change prevented us from comparing the result obtained with that obtained by the indirect method. This is becuase of the different assumptions underlying the two methods.

TABLE 6.3.

The direct estimate of technical change for the Whole Economy.

parameter	estimated value	standard error of the estimate	t-values
ln A	-0.07111	0.16527	-1.6404
λ	-0.05581	0.01438	-3.8823
λ^2	0.00246	0.00093	2.6366
α	0.88111	0.30608	2.8787

Method of estimation is Cochran-Orcutt procedure; the sum squared of residual of the regression is 0.041736; the coefficient of determination and Durbin-Watson statistic are 0.95750 and 1.8263 respectively.

Source: table B.1.

6.2.2. AGRICULTURAL SECTOR

It is well known that the agricultural sector has a certain "role" to play in the process of economic development not only because the sector contains the largest part of the economy's population but also because it comprises the major part of the gross domestic product and labour force. Johnston and Mellor, (1961) identified those roles as

1. release of labour force to other sectors.
2. supply of foodstuffs and intermediate inputs at appropriate prices.
3. supply of funds to finance industralization.

4. supply of hard currency through agricultural exports.

5. creation of a market for industrial products.

The seeds of civilization have their origin in the fertile plain between the Eupghrates and the Tigres where man first reversed his role from hunter to domesticating animals and harvesting. Therefore the origin of agriculture itself, and indeed economics, lie in Iraq and this sector continues to play a role in this country's development, although a declining one.

1. Indirect Estimate

To what extent the agricultural sector can play those roles is dependent on increasing its productivity. The estimate of total factor productivity or technical change as measured by Solow's method for this sector during the period 1960-1978 is presented in table (6.4) and is also shown in figure (6.2).

Despite the high fluctuation in the index among different years, it shows a steady decline throughout the period. Its lowest rate was during 1975 but since then it started picking up. Overall the period the index declined by 1.27 per cent per year.

Among the different subperiods, the 1973-1978 has the highst rate of growth of technical change, when it reached 6.37 per cent per annum or 24.8 per cent overall the period. During the first subperiod an annual growth rate of 2.89 per cent was achieved while in the

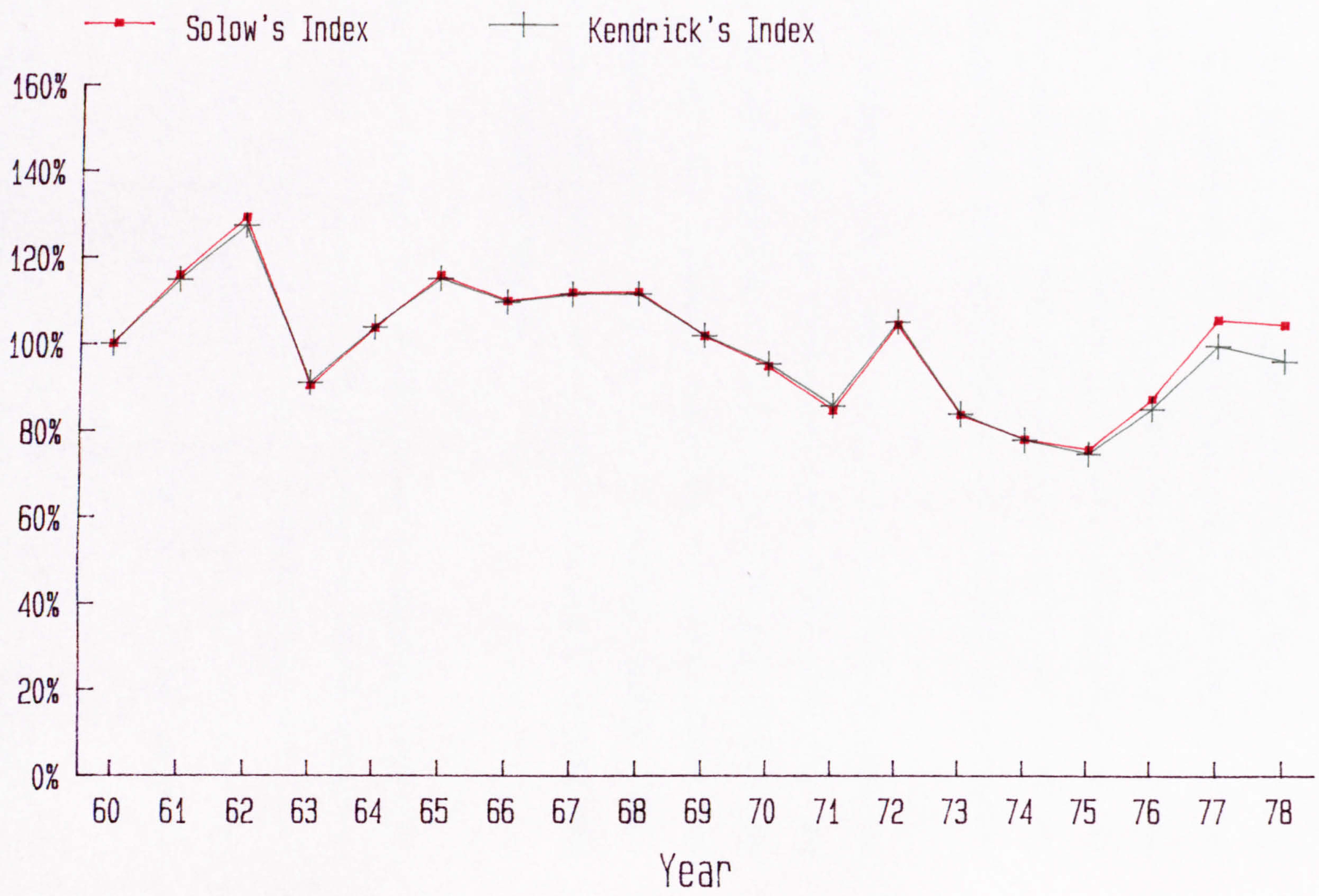
TABLE 6.4.

Solow's index of technical change for the Agricultural sector, 1960-1978

year (1)	ΔQ/Q (2)	ΔL/L (3)	ΔK/K (4)	ΔTFI (5)	ΔA/A (6)	Solow's index (7)
1960						100.000
1961	22.517	6.3496	7.4811	6.6892	15.828	115.828
1962	18.356	5.9577	8.7324	6.7905	11.566	129.216
1963	-24.686	5.6227	5.1643	5.4851	-30.171	90.2290
1964	19.401	5.3348	2.6825	4.5388	14.862	103.640
1965	19.469	9.7272	3.4852	7.8539	11.615	115.678
1966	2.6005	9.2610	4.3050	7.7737	-5.1731	109.694
1967	8.3487	6.7355	6.4465	6.6488	1.6999	111.558
1968	6.5437	6.4718	5.6921	6.2378	0.3058	111.900
1969	-4.4713	4.2118	5.5103	4.6015	-9.0729	101.747
1970	-0.3612	6.0701	7.6399	6.5412	-6.9024	94.7240
1971	-5.5751	3.5361	9.0401	5.1879	-10.763	84.5288
1972	27.212	2.3977	6.7147	3.6933	23.518	104.409
1973	-21.041	-4.8124	7.8256	-1.0196	-20.021	83.5047
1974	-8.0332	-5.2059	7.9757	-1.2499	-6.7832	77.8403
1975	-6.7409	-8.3132	7.5682	-3.5470	-3.1939	75.3541
1976	8.3909	-14.332	9.8253	-7.0826	15.473	87.0141
1977	18.522	-9.5562	13.702	-2.5761	21.098	105.347
1978	2.6448	0.0000	12.365	3.7108	-1.0660	104.251

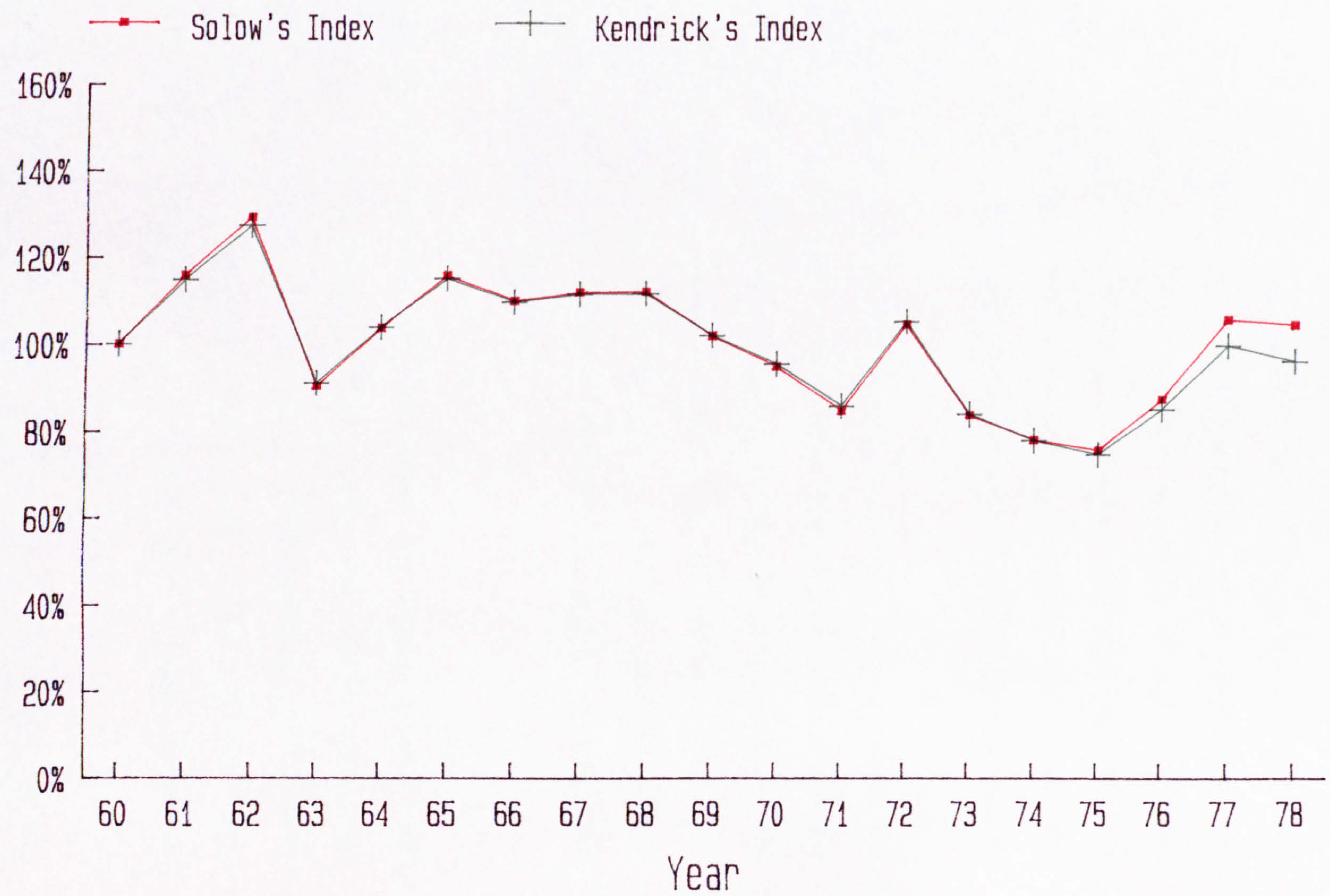
Sources: Tables A.9 and C.1.

Figure 6.2 Solow's and Kendrick's Indices of Technical Change for the Agricultural Sector 1960-1978



Sources: Tables 6.4 and 6.5

Figure 6.2 Solow's and Kendrick's Indices of Technical Change for the Agricultural Sector 1960-1978



Sources: Tables 6.4 and 6.5

second subperiod the index declined by 0.82 per cent per annum.*

The decline in the technical change index might be explained as follows; urbanization has progressed too fast and too early, especialy in the 1970s for the income level attained by the country, generating crucial problems of employment, income concentration and economic dualism. The agricultural sector has low productivity, and has weakeness in education, health, transport, storage, and most of all, social infrastructure. This contributed directly and indirectly to not achieving a high rate of growth in the technical change index.

Different subperiods have their own obstacles which caused the decline in the agricultural production. The first subperiod was affected by the unavailability of agricultural machinery, capital and technical advice. The available machinery at that period was estimated to be only 10 per cent of what was needed (Hashim, 1970). Also the pricing policy and the lack of education played an important role in the decline of production.

Although the government helped the farmers by supplying them with capital, machinery and technical advice during the second subperiod, the rate of agricultural progress was disappointing. Still many factors were attributable to this such as the salinity of the land, lack of absorption of new technology but "perhaps the most important

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* *growth rate for the first and second subperiods calculated in every year and then taking the average as the representative of growth rates. This due to inability to obtain those rates by OLS method.*

was the involvement of the state and socialist sector in small circles of agricultural production and the emergence of red tape and bureaucracy in authorized state agencies" (Al-Baath, 1982).

The agricultural production in the last subperiod was affected by the diversion of the water from the Euphrates river, which is the main source of irrigation for more than half of the agricultural land, by the Syrian dam.

On the input side we find supply of capital increasing rapidly while its productivity is rapidly declining. Labour productivity declined in both first and second subperiods before increasing sharply during the last subperiod (see table C.2 in appendix C). The decline in capital productivity might reflect the fact that the intensive technology imported may not have been accompanied by sufficient labour skills.

Kendrick's index of technical change along with total factor inputs and value added indices is presented in table (6.5) and shown in figure (6.2).

Through using Kendrick's methodology, this index gives the same picture as that given by Solow's index, except that it shows a larger declining rate. The rate of decline throughout the period was 1.59 per cent per annum. The behaviour of the index during the different subperiods is the same as that of Solow's.

TABLE 6.5.

Kendrick's index of technical change for the Agricultural sctor, 1960-1978

year (1)	output (2)	T.F.I (3)	kendrick's index (4)
1960	100.000	100.000	100.000
1961	122.518	106.689	114.836
1962	145.007	113.940	127.266
1963	109.210	120.186	90.8673
1964	130.399	125.620	103.804
1965	155.786	135.475	114.993
1966	159.838	146.079	109.419
1967	173.182	155.800	111.157
1968	184.515	165.544	111.460
1969	176.264	173.114	101.820
1970	175.628	184.384	95.2512
1971	165.836	193.779	85.5801
1972	210.963	200.884	105.018
1973	166.574	198.898	83.7486
1974	153.193	197.183	77.6910
1975	142.866	192.029	74.3983
1976	154.854	182.896	84.6681
1977	183.536	184.862	99.2830
1978	188.391	196.616	95.8167

Sources:Tables A.9 and C.1.

2. Direct estimate

By using the direct estimation method we have with the results as presented in table (6.6)

TABLE 6.6.

The direct estimate of technical change for the Agricultural sector.

parameter	estimated value	standard error of the estimate	t-values
ln A	-0.96612	0.26129	-3.6975
λ	-0.01881	0.00777	-2.4200
α	0.45403	0.12579	3.6096
$(1-\alpha)$	0.54597	———	4.3405

Method of estimation is ordinary least squares; the sum squared of residual of the regression is 0.25751; the coefficient of determination and Durbin-Watson statistic are 0.6088 and 1.39088 respectively.
Source: table C.1.

Unfortunatly our estimated equation does not have a high explanatory power as is shown by the low coefficient of determination and the simulation results (see table C.3. and figure C.1). All the coefficients including that of time trend are significant at the 95 per cent significant level. However, the most satisfactory result is the one with the assumption of constant rate of growth of technical change, as specified. According to this specification technical change is declining by an annual rate of 1.88 per cent, which is not too far from that obtained by Solow's and Kendrick's methods.

6.2.3. MANUFACTURING SECTOR

Iraq in its development efforts has given special attention to the industrial sector, particularly the manufacturing industries. Its financial situation has enabled it to import the latest technology available.

As a socialist country Iraq has assigned to the government the role of directing and implementing industrial development. In addition to this, different actions for attracting private sector contributions to the industralization process have been taken by the government, for example through its trade and tax policies -exemption from tax for the early stage of production, and exemption from stamp duties, real estate tax, tax on their imports of capital and raw materials. The industrial bank was established to provide loans for private investors at a very low interest rate. Judging from the size of its loans to manufacturing, which increased 15 times between 1967 and 1978, one can get some idea of the importance of the role played by this institution. Furthermore, an equal opportunity has been given to the Arabic investor; for this purpose law No 22 of 1973 was issued. By this law Arabic investors have been given exemptions from tax and customes duties equal to those given to the local investors.

1. Indirect Estimate

With regard to the technological changes generated in this sector (see table 6.7 and the corresponding graphical display figure 6.3) as measured by Solow's index for the period 1960-1978 we find that the

TABLE 6.7.

Solow's index of technical change for the Manufacturing sector, 1960-1978.

year (1)	ΔQ/Q (2)	ΔL/L (3)	ΔK/K (4)	ΔTFI (5)	ΔA/A (6)	Solow's index (7)
1960						100.00
1961	12.226	0.0000	5.2715	3.5166	8.7097	108.54
1962	9.1812	0.0000	7.9788	5.3226	3.8586	112.44
1963	-5.7335	0.0000	13.346	8.9035	-14.637	95.490
1964	-2.8325	0.0000	11.430	7.6249	-10.457	85.146
1965	13.194	3.8461	10.501	8.2855	4.9088	89.140
1966	3.5641	3.7037	10.844	8.4671	-4.9029	93.720
1967	2.7721	0.0000	11.765	7.8485	-5.0763	88.600
1968	17.536	4.2857	11.298	8.9637	8.5721	95.992
1969	7.6887	1.3698	10.376	7.3780	0.3107	96.043
1970	14.466	4.1216	10.183	8.1654	6.3006	101.90
1971	3.9101	11.226	9.3706	9.9885	-6.0783	95.771
1972	8.2850	6.3010	7.4899	7.0942	1.1908	96.827
1973	8.1637	-0.9330	9.0826	5.7483	2.4154	98.895
1974	7.1225	1.2742	11.798	8.2949	-1.1723	97.395
1975	34.630	29.431	14.776	19.655	14.975	112.45
1976	33.927	-3.5503	20.061	12.201	21.727	136.01
1977	31.917	7.7563	14.760	12.429	19.489	162.20
1978	-2.9485	1.3013	16.559	11.480	-14.428	137.99

Sources: table 5.3 and D.1.

Figure 6.3 Solow's and Kendrick's Indices of Technical Change for the Manufacturing Sector 1960-1978

Sources: Tables 6.7 and 6.8

annual compounded growth rate of technical change was 1.74 per cent, or an overall growth rate of around 38.0 per cent. This index behaves as it is supposed to because in the overall view it increases with time. The first subperiod, 1960-1967, comparatively had the lowest growth rate, since it declined by 2.81 per cent per annum. During the second subperiod, 1968-1972, the index fluctuated in the different years without any significant tendency to increase or decrase. During the third subperiod, 1973-1978, the highest growth rate of technical change was enjoyed when it was around 10.2 per cent per annum.

The low rate of growth of technical change achieved during the first subperiod might be attributed to: first, the traditional technology used at that time and second, to the low level of experience of the labour force and the entrepeneurs, and third, the political instability.

During the second subperiod the general performance was still poor despite the fact that the growth rate had now taken a positive turn. The poor performance of the index during this subperiod might be attributed to both the inadequate assimilation of modern technology and the low productivity of the production factors. Capital productivity registered an annual rate of decline of less than 1 per cent while labour productivity only registered an annual increase of 2.41 per cent. With regard to these marginal changes in productivity the eight and ninth Iraqi Baath Party conferences commented as follows:

(i) The technical standard of those working in this sector was weak and they did not keep up adequately with modern technological developments. The quantity and quality of the manpower base for industry is still below the required standard and major efforts are needed to upgrade and develop skills.

(ii) An imbalance in the quantity and quality of mid-level cadres and engineering cadres continues. Engineering cadres are thus inundated with ordinary technical work, and aspects of development and innovation in the production process are thus ignored.

The higer rate of growth of technical change achieved during the last subperiod might be attributed to: first the modern technology imported after the increase in government revenue, as a result of the success of the nationalization of the oil industry and the increase in the oil price. Second point is that the increase in the level of experience of the labour force was enhanced through: (a) the process of learning by doing, and its productivity rose by 15.2 per cent per annum in the last subperiod, compared to 2.39 per cent in the first subperiod, (b) the increase in the number of students graduating from industrial schools*, (c) the importation of foreign skilled labour.

The technical change estimation according the Kendrick's method is presented in table (6.8) and figure (6.3). By looking at the behaviour of this index according to the individual years we see a decline during 1963-1964, due to political instability and the

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* *the number of industrial schools rose to 45 in 1979 while there were only 10 in 1968.*

TABLE 6.8.

Kendrick's index of technical change for the Manufacturing sector, 1960-1978.

year (1)	output (2)	T.F.I (3)	Kendrick's index (4)
1960	100.000	100.000	100.000
1961	112.226	103.517	108.414
1962	122.530	109.120	112.289
1963	115.505	119.241	96.8669
1964	112.233	129.065	86.9586
1965	127.041	140.402	90.4838
1966	131.569	153.159	85.9035
1967	135.217	166.961	80.9870
1968	158.928	183.310	86.6988
1969	171.148	198.964	86.0194
1970	195.906	216.928	90.3092
1971	203.566	237.988	85.5363
1972	220.431	255.291	86.3451
1973	238.427	273.805	87.0790
1974	255.409	301.245	84.7844
1975	343.857	352.619	97.5152
1976	460.520	409.053	112.582
1977	607.507	465.338	130.552
1978	589.595	532.787	110.662

Sources: Tables A.9 and D.1.

nationalization of large private enterprises. The decline is also observed during the 1967 war. However, the growth rate of technical change obtained by using this method is lower than that obtained by using Solow's method.

2. Direct Estimate

The growth rate of technical change in the manufacturing sector was obtained by using the direct estimate as presented in table (6.9)

TABLE 6.9.
The direct estimate of technical change for the Manufacturing sector.

parameter	estimated value	standard error of the estimate	t-values
ln A	-0.48082	0.07871	-6.1088
λ	-0.09284	0.02971	-3.1248
λ^2	0.00492	0.00093	6.2210
α	0.72130	0.28240	2.5541
$(1-\alpha)$	0.27870	———	0.9867

Method used for estimation is Cochran-Orcutt procedure;the sum squared of residual of the regression is 0.069120;the coefficient of determination and Durbin-Watson statistic are 0.9870 and 1.8288 respectively.

Source table D.1.

Before we discuss the results of table 6.9 a problem should be mentioned with regard to the estimate that is multicolinearity between the independent variables. In general the multicolinearity with regard to this sector is a problem which can be attributed to various factors such as under-utilization of capacity and the existence of uneconomic units in this sector.

In table 6.9 the introduction of a time trend variable to the production function changes the situation radically (See table A.9 in appendix A for our estimate of the Cobb-Douglas production function without a time trend). The fit improved marginally and the coefficient of L increased whereas that of K decreased, and becomes insignificant statistically. This change suggested the possiblity of multicolinearity. In fact the multicolinearity between capital and time, shown in the simple correlation matrix, is as high as 0.941 per cent.

According to the selection procedure technological change in this sector can be best quantified by introducing t^2 as another variable along with simple time trend in the production function. In fact with this specification more than 98 per cent of the variation in the dependent variable is explained. Furthermore, it succeeded in simulating output levels for the period 1961-1978 fairly well (see table D.3 in Appendix D)

6.2.4 THE MININIG AND QUARRYING SECTOR

This sector contains the oil industry and therefore is of major significance to overall economic development in Iraq. This fact has been well establisheed because even in the early days, 1935/36, oil exploration was the first to introduce new technology and of course as the result this had an initial advantage over other sectors.

Accurate measurment though is further complicated because of the fact that output is measured in constant prices, which means that increases in price would be eliminated through the deflation process, thus distoring the output figures which are used together with the inputs to determine technological change. In reality the price of oil quadruppled in the early 1970s, thus severely curtailing demand, and in order to keep up the price OPEC set production quotas for each of its members thus ensuring that supply would not surpass demand which would have pushed down its price again. Furthermore, according to Abdul-Rasool, (1982) "the decline in the share of the oil sector confirmed the achievement of the principle objective of the development strategy, namely to achieve the highest possible growth rate in GDP and simultaneously reduce the imbalance in the economy to the lowest possible level".

1. Indirect Estimate

The calculation results of Solow's index are presented in table (6.10) and figure (6.4), and it shows a large variation between the different years with an overall period decline of 13.6 per cent being 0.81 per cent per annum. Among the different subperiods the 1968-1972 one experienced the highest rate of decline with regard to the growth of technical change, at 4.79 per cent per annum or 25.0 per cent for the overall period. During the first subperiod the index has a declining rate of 25.0 per cent for the period overall and 4.03 per cent annually. The last subperiod was marked due to the fact that nationalization had taken place in the previous period, and

TABLE 6.10.

Solow's index of technical change for the Mining and Quarrying sector, 1960-1978.

year (1)	ΔQ/Q (2)	ΔL/L (3)	ΔK/K (4)	ΔTFI (5)	ΔA/A (6)	Solow's index (7)
1960						100.00
1961	3.2558	4.5455	35.437	14.260	-11.004	89.134
1962	-0.9468	4.3478	24.190	10.588	-11.534	78.932
1963	11.466	4.1667	4.3093	4.2115	7.2542	84.658
1964	10.199	4.0000	1.4046	3.1838	7.0156	90.588
1965	8.0282	3.8461	0.7333	2.8673	5.1610	95.250
1966	2.3576	3.7037	0.8887	2.8188	-0.4611	94.799
1967	-18.089	3.5714	1.1225	2.8013	-20.890	74.985
1968	30.963	3.4483	1.0307	2.6880	28.275	96.178
1969	-0.8178	3.3333	0.8632	2.5566	-3.3744	92.922
1970	-6.7919	3.2258	0.7780	2.4561	-9.2480	84.319
1971	2.7541	3.1250	5.0955	3.7446	-0.9968	83.491
1972	1.3112	6.0606	6.6114	6.2338	-4.9226	79.383
1973	37.470	5.7143	7.7173	6.3442	31.126	104.10
1974	-3.5344	3.7837	16.486	7.7783	-11.313	92.382
1975	5.1697	4.1666	26.998	11.346	-6.1768	86.770
1976	49.920	64.500	17.882	49.840	0.0803	86.659
1977	-0.1709	11.550	23.843	15.413	-15.546	73.202
1978	19.052	-3.2697	10.497	1.0594	17.930	86.418

Sources: table 5.3 and e.1.

Figure 6.4 Solow's and Kendrick's Indices of Technical Change for the Mining and Quarrying Sector 1960-1978

Source: Tables 6.10 and 6.11

subsequently the index declined at a lower rate than that of the previous subperiod. However, its declining rate was 4.55 per cent per annum resulting in an overall period per centage of 17.0.

According to our findings, there was a decline in the rate of growth in technical change during the period before nationalization took place. In fact the index declined by 1.49 per cent per annum during the period 1960-1971. This might be due to the fact that the low investment in this sector, which included the oil industry, up to 71 was totally controlled by foreign companies. The total amount invested during the period 1963-71 amounted to only ID 16.6 Million. Since investment serves as a vehicle for the introduction of technical progress, one might expect a fall in the rate of growth of technical change. Also the unjustifiable reductions in the production of oil by foreign holding companies, whenever their whims led them to try and influence the local governments for their own goals, no doubt played a role too. This was further enhanced by the unwillingness of the foreign oil companies to train local people for employment within the industry which was ostensibly done to try to prevent nationalization.

During the period after nationalization, 1972-1978, the index increased by 1.43 per cent per annum which might be attributed to the huge investment incurred to make up for the low level of the pre-nationalization period.

The technical change index estimated by Kendrick's methodology, for the mining and quarrying sector according to the period 1960-1978 is presented in table (6.11) and shown in figure 6.4.

According to this measure production efficiency in this sector declined by 8.92 per cent overall or by 0.52 per cent per annum. The decline was most prevalent in the period 1968-1972 when its annual per centage stood at 4.60, being equivalent to 16.8 per cent for the whole period. This result is again in accordance with the above results using Solow's index.

From the information in table (6.11) we can draw some important conclusions. Firstly the technical change index increased by 1.80 per cent per year after the nationalization of 1972 despite the large increase in the total factor inputs which amounted to an annual growth rate of 14.3 per cent. The high increase in total factor inputs does not result in a decline in the growth rate of technical change, which confirms the fact that there is a positive correlation between technical change and investment. Secondly, the technical change that took place after nationalization was much higher, at an increasing rate of 1.8 per cent per annum, than that which occured before when it was declining at around 1.91 per cent per annum.

One final comment is worth mentioning on the results already obtained by this method. It is generally accepted that the oil industry is one of the highest capital intensive industries, thus the share of capital is expected to exceed that of labour. However, in our estimate the share of capital in output is underestimated due to the slow movement of the capital stock series. In fact for the period 1963-1969 total investment was as low as ID 9.35 million, which is

TABLE 6.11.

Kendrick's index of technical change for the Mining and Quarrying sector, 1960-1978.

year (1)	output (2)	T.F.I (3)	Kendrick's index (4)
1960	100.000	100.000	100.000
1961	103.256	114.260	90.3691
1962	102.278	127.679	80.1058
1963	114.005	133.074	85.6703
1964	125.633	136.965	91.7262
1965	135.719	140.492	96.6030
1966	138.919	144.109	96.3985
1967	113.790	147.863	76.9560
1968	149.022	151.572	98.3178
1969	147.804	155.190	95.2407
1970	137.765	158.762	86.7747
1971	141.559	164.886	85.8525
1972	143.415	175.221	81.8480
1973	197.153	186.559	105.679
1974	190.185	202.671	93.8395
1975	200.017	230.069	86.9380
1976	299.866	329.315	91.0576
1977	299.354	382.617	78.2386
1978	356.387	391.293	91.0794

Sources: Tables A.9 and E.1.

only one-third of the investment during the year 1961. To illustrate the possible bias I have included an alternative estimate of the capital and labour shares in the output. A higher share was given to capital and a corresponding decrease in labour's shares. These shares were used in constructing Kendrick's index. However when higher shares for capital were assumed the index declined further during the period as well as during the last subperiod. This is due to the fact that assuming a higher rate for the faster growing input would result in an increase in the total factor inputs and consequently the technical change index would decline.

2. Direct Estimate

The technological change which occured during the underlying period as calculated by direct methods is shown in table (6.12).

TABLE 6.12.

The direct estimate of technical change for the Mining and Quarrying sector.

parameter	estimated value	standard error of the estimate	t-values
ln A	2.35240	0.48855	4.81520
λ	0.00055	0.00362	0.15235
α	0.30847	0.21543	1.43190
$(1-\alpha)$	0.69153	———	3.21000

Method of estimation is Cochran-Orcutt procedure; the sum squared of residual of the regression is 0.116750; the coefficient of determination and Durbin-Watson statistic are 0.9501 and 2.0882 respectively.

Source: table E.1.

We can easily notice the high degree of imprecision attached to the coefficients of labour and time, recalling again that this might be due to the high correlation between the explanatory variables. However, in all the three specifications the growth rate of technical change turns out to be positive. This result does not corresponed totally with that obtained using the indirect methods. Testing for a variable rate of technical change does not give us a better estimate than that of constant rate of technical change.

According to this method technical change is growing at a constant rate of 0.06 per cent per annum.

6.2.5. ELECTRICITY, GAS AND WATER

The importance of this sector lies not only in its support to all other sectors but even more so in being reflected in the general socio-economic infrastructure, which in line with government policy receives a great deal of attention and support.

Let us examine the productivity in this sector. The real output increased at an annual rate of 10.1 percent per year between 1960-1978 (see table F.5). Labour input, measured in number of persons employed, rose at 3.96 per cent per year. Capital input, in terms of real capital stock, increased 11.0 per cent per annum. Based on the fact that the underlying production function is of constant return to scale, obiously the rapid output growth rate cannot fully explained by the increases in the input factors.

1. Indirect estimate

Table (6.13) and figure (6.5) show Solow's index of technical change for the electricity, gas and water sector during the period 1960-1978. This thriving industry is reflected in the fact that the index increased at a rate of 2.76 per cent per annum with the overall result being 63.3 per cent. This fact is all the more remarkable since during the middle period (1968-72) there was a negative growth rate of 13.7 per cent per annum and the highest decline was registered during 1971. This occurance coincided with huge investments in the industry most of which were of a long-term nature and as such would only show "profitable" returns in the future, as is shown in the next subperiod. The total investment during this period amounted to I.D. 37.7 million compared to I.D. 29.2 million for the period 1951-1967.

As indicated above the investments "paid off" during the last subperiod when the highest rate of growth, 6.71 per cent per annum, was observed.

TABLE 6.13.

Solow's index of technical change for the Electricity, Gas and Water sector, 1960-1978.

year (1)	ΔQ/Q (2)	ΔL/L (3)	ΔK/K (4)	ΔTFI (5)	ΔA/A (6)	Solow's index (7)
1960						100.00
1961	40.399	0.8475	23.416	2.7655	37.633	120.84
1962	10.124	0.8403	12.478	1.4613	8.6630	120.40
1963	-9.1935	0.0000	9.8829	0.0000	-9.1935	99.383
1964	109.06	0.0000	14.755	0.0000	109.06	198.32
1965	12.404	0.0000	19.704	0.0000	12.404	188.06
1966	0.9826	1.6667	15.290	3.5516	-2.5690	164.49
1967	1.1227	1.6393	14.038	3.2072	-2.0845	146.16
1968	11.917	1.6129	13.080	2.9401	8.9770	147.19
1969	11.111	1.5873	7.8175	1.7293	9.3818	150.87
1970	5.9524	0.7812	6.9718	0.7591	5.1933	149.95
1971	-33.146	0.7752	9.0860	0.9816	-34.128	86.377
1972	15.126	12.307	7.4717	12.816	2.3102	92.935
1973	16.788	10.274	6.6514	9.5236	7.2647	103.58
1974	16.250	5.5900	5.5866	4.3522	11.898	114.84
1975	22.258	7.6470	2.9272	3.1196	19.138	136.14
1976	11.565	10.929	20.772	31.636	-20.070	125.85
1977	9.2629	12.315	17.119	29.382	-20.119	116.97
1978	49.675	14.474	8.4972	17.143	32.535	163.27

Sources: table A.9 and F.1.

Figure 6.5 Solow's and Kendrick's Indices of Technical Change for the Electricity, Gas and Water Sector 1960-1978

Sources: Tables 6.13 and 6.14

Kendrick's index of technical change for the electricity, gas and water sector is presented in table (6.14) and figure (6.5). As usual this index does not differ substantially from the one obtained through Solow's methodology. It shows a generally increasing trend for the period 1960-1967, except for the years 1963 and 1964. After this a period of decline is noted with the lowest point during 1971 when the rate of technical growth fell by 13.9 per cent compared to the base year of 1960. The notable exceptions during this period were the years 1969 and 1970, i.e. those preceding the year with the highest rate of decline. The final period, from 1973 onwards showed an increasing trend although some setbacks were experienced during 1976 and 1977.

This index increased by 56.7 overall for the period, being 2.53 per cent per year. The lowest growth rate was registered for the 1968-1972 subperiod. During this subperiod the annual decline was at 12.0 per cent per annum. As with the majority of the sectors the highest growth rate in the index occured during the last subperiod. In fact the index's annual growth rate amounted to 6.71.

TABLE 6.14.

Kendrick's index of technical change for the Electricity, Gas and water sector, 1960-1978.

year (1)	output (2)	T.F.I (3)	Kendrick's index (4)
1960	100.000	100.000	100.000
1961	140.399	119.638	117.353
1962	154.613	132.602	116.599
1963	140.399	144.025	97.4824
1964	293.516	162.765	180.332
1965	329.925	191.482	172.301
1966	333.167	218.442	152.520
1967	336.908	246.961	136.421
1968	377.057	277.247	136.001
1969	418.953	297.807	140.679
1970	443.890	317.445	139.832
1971	296.758	344.768	86.0748
1972	341.646	371.419	91.9839
1973	399.002	396.874	100.536
1974	463.840	419.047	110.689
1975	567.082	432.451	131.132
1976	632.668	519.720	121.733
1977	691.272	607.308	113.826
1978	1035.31	660.845	156.665

Note: all figures are in per centages.

Sources: Tables A.9 and F.1.

2. Direct Estimate

The estimation of the rate of growth of technical change, during the period 1960-1978, using the direct method is presented below in table (6.15).

TABLE 6.15.

The direct estimate of technical change for the Electricity, Gas and Water sector.

parameter	estimated value	standard error of the estimate	t-values
ln A	-1.58040	0.64507	-2.44990
λ	0.01115	0.02959	0.37671
α	0.70343	0.43505	1.61690
$(1-\alpha)$	0.29657	———	0.68169

Method of estimation is Cochran-Orcutt procedure;the sum squared of residual of the regression is 0.59818;the coefficient of determination and Durbin-Watson statistic are 0.875 and 1.7802 respectively.

Source: table F.1.

Unfortunately the standard error of the estimated coefficients of the variables introduced in the production function to represent the growth rate of technical change are high. However, according to the proposed test the best specification for quantifying the rate of growth of technical change is by assuming it is growing at a constant rate.

As can be seen from table 6.15 technical change is growing by an annual growth rate of 1.12 per cent. Obviously this result is lower than that obtained by the indirect method.

6.2.6. CONSTRUCTION SECTOR

This sector came into the forefront after the 1968 revolution when the government recognized the need to build up the infrastructural base necessary for the development of all the other sectors.

The primary objectives lay in housing, road and bridge building as well as other more general development projects such as schools, hospitals, offices etc. Overall policy reflected this since this sector was now included in public investment programes which even led to the establishment of the Construction Bank; this confidence was in turn reflected in the private sector where the number and amount of loans granted for house building increased at zero or very low interest rates.

1. Indirect Estimate

This sector proved to be one of the leading sectors regarding the high growth rate of technical change, as can be observed from Solow's index in table (6.16) and figure (6.6). During the period 1960-1978 it expanded by more than 52 per cent being 1.88 per cent annually. Most of the growth took place during the last subperiod, when it ammounted to 15.7 per cent per annum. Conversely the largest decline occured during the first subperiod at a yearly rate of 2.45 per cent totalling 16.0 per cent. The index kept declining during the middle period but at a slower rate.

The following factors were instrumental in achieving this high rate of growth after 1972.

(1) The government's incentive to raise the standard of living by providing better housing, which it could finance from increased revenues.

(2) The importance of this sector to the implementation of the national development planning. In fact this sector among others formed one of the "bottlenecks" after 1974.

(3) The less sophisticated technology used in this sector compared with the technologies used in other sectors such as manufacturing, electricity, mining etc. Thus labour productivity could be increased through high absorption of less complex technology. In fact labour productivity increased by an average of 5.66 per cent annually for the overall period, whilst the highest average of 16.2 per cent per annum was achieved during the last subperiod.

(4) The implementation of projects in this sector was based mainly on

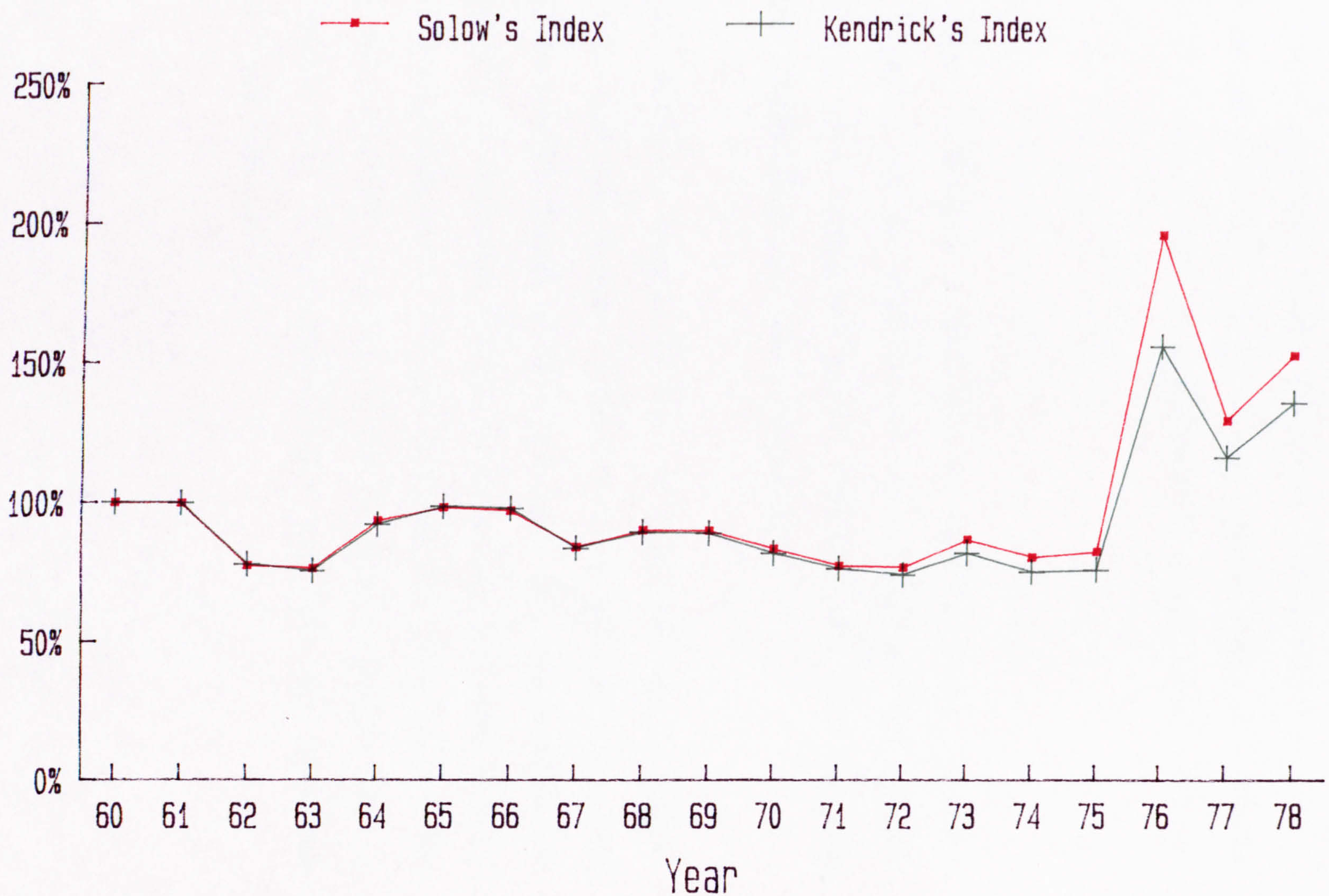
TABLE 6.16.

Solow's index of technical change for the Construction sector, 1960-1978.

year (1)	ΔQ/Q (2)	ΔL/L (3)	ΔK/K (4)	ΔTFI (5)	ΔA/A (6)	Solow's index (7)
1960						100.00
1961	6.1081	0.1724	9.64427	6.3904	-0.2823	99.735
1962	-18.856	-13.941	12.6172	3.4935	-22.350	77.394
1963	0.0000	-13.800	9.47503	1.4794	-1.4794	76.270
1964	28.740	9.5128	4.32749	6.1088	22.633	93.516
1965	18.686	29.449	5.32511	13.612	5.0735	98.232
1966	8.8393	14.566	7.98297	10.245	-1.4052	96.885
1967	-12.440	-15.571	9.36422	0.7981	-13.240	84.041
1968	16.615	11.675	8.33709	9.4838	7.1308	90.022
1969	3.1066	1.5152	4.11814	3.2239	-0.1173	89.906
1970	1.0390	0.0000	12.9844	8.5239	-7.4849	83.437
1971	2.8278	8.6567	10.7496	10.031	-7.2029	77.433
1972	5.7500	-4.9450	12.7075	6.6433	-0.8933	76.746
1973	20.804	2.6012	10.5949	7.8488	12.955	86.691
1974	3.1311	2.8310	14.4211	10.440	-7.3084	80.351
1975	31.120	24.092	30.7589	28.469	2.6507	82.484
1976	166.28	24.724	30.7139	28.656	137.63	196.00
1977	-2.8804	33.274	30.3340	31.344	-34.225	128.91
1978	36.318	23.240	15.3552	18.064	18.254	152.45

Sources: table 5.3 and G.1.

Figure 4.6 Solow's and Kendrick's Indices of Technical Change for the Construction Sector 1960-1978



Sources: Tables 6.16 and 6.17

contracting foreign companies using their own technologies and highly skilled labour, so that there is no need to use low productive local labour force.

The estimated technical change index for the construction sector during the period 1960-1978, by using the second indirect estimate i.e. Kendrick's methodology is presented in table (6.17) and in figure (6.6).

This index's behaviour is the same as that of Solow's, except that the technical change figures are underestimated. The overall increase in the index during the period 1960-1978 was 35.2 per cent and its annual compounded rate was 1.69 per cent.

Among the different subperiods that of 1960-1967 had the lowest annual rate of technical change at negative 2.54 per cent per annum there being an overall figure of 16.5 per cent. The second subperiod did not show a much different picture at an annual declining rate of 5.18 per cent totalling up to 17.2 per cent for the whole period. The next subperiod, 1973-1978, enjoyed by far the highest growth rate of technical change when it amounted to 13.8 per cent per annum and stood at 65.3 per cent over all.

TABLE 6.17.

Kendrick's index of technical change for the Construction sector, 1960-1978.

year (1)	output (2)	T.F.I (3)	Kendrick's index (4)
1960	100.000	100.000	100.000
1961	106.108	106.390	99.7346
1962	86.1002	110.674	77.7960
1963	86.1002	114.268	75.3494
1964	110.846	120.537	91.9602
1965	131.558	133.700	98.3985
1966	143.187	146.755	97.5687
1967	125.372	150.159	83.4927
1968	146.202	163.847	89.2311
1969	150.744	169.576	88.8944
1970	152.310	186.442	81.6929
1971	156.617	205.654	76.1557
1972	165.623	224.176	73.8807
1973	200.078	244.650	81.7813
1974	206.343	275.058	75.0181
1975	270.556	356.780	75.8328
1976	720.439	463.146	155.553
1977	699.687	605.605	115.535
1978	953.798	705.631	135.170

Sources: Tables A.9 and G.1.

2. Direct Estimate

The result of estimating the different specification of technical change applied to the construction sector is shown below in table (6.18).

TABLE 6.18

The direct estimate of technical change for the Construction sector.

parameter	estimated value	standard error of the estimate	t-values
ln A	-0.33035	0.46179	-0.71537
λ	-0.04854	0.03335	-1.45540
λ^2	0.00452	0.00139	3.25850
α	0.23228	0.30837	0.75325
$(1-\alpha)$	0.76772	———	2.48960

Method of estimation is ordinary least squares;the sum squared of residual of the regression is 0.39068;the coefficient of determination and Durbin-Watson statistic are 0.957 and 1.7856 respectively.

Source table G.1.

In table (6.18) all the coefficients are significant except that of labour and the constant term. However, the overall fit of the equation is very high and it simulates the output levels generated in this sector fairly well.

The rate of growth of technical change which occurred in this sector is variable and increasing.

6.5.7. DISTRIBUTION SECTOR

This sector was forced into rapid expansion because it provided the transportation and communication networks for the increases in goods and services produced and exported, and imported.

1. Indirect Estimate

Solow's index of technical change in the distribution sector show an increasing trend for the overall period as can be seen in table (6.19) and figure (6.7).

The high rate of growth of the index in this sector might be attributed to the fact that it includes some of the fastest growing industries such as transportation and communications and because of the omission of the value of the government's inputs, such as roads, airports etc.

The overall rate of growth of the index between 1960-1978 amounted to 85.3 per cent which is equivalent to an annual growth rate of 3.11 per cent. Among the different subperiods, the 1973-1978 showed the highest growth rate of technical change, its annual rate being 7.97 and the overall one 65.8 per cent. The high growth rate of this period might be attributed to the high priority given to the sector after it was discovered that many industries included in it were inadequately based, e.g. transportation needed to be developed after the 1974 economic boom to sustain it. In fact equally emphasized are projects designed to expand ports, transportation and

TABLE 6.19.

Solow's index of technical change for the Destribution sector, 1960-1978.

year (1)	ΔQ/Q (2)	ΔL/L (3)	ΔK/K (4)	ΔTFI (5)	ΔA/A (6)	Solow's index (7)
1960						100.00
1961	18.576	4.2857	10.207	10.571	8.0043	110.79
1962	2.1747	3.6530	11.095	9.7942	-7.6195	104.28
1963	-2.7274	3.9648	9.8412	9.4294	-12.157	93.675
1964	16.075	3.8136	7.9486	7.3255	8.7491	102.87
1965	23.649	3.6735	6.6223	5.8790	17.770	121.63
1966	5.1544	3.5433	5.5297	4.7351	0.4193	122.55
1967	3.4331	3.4220	6.2485	5.1675	-1.7344	120.13
1968	2.0510	2.9412	4.2534	3.0233	-0.9723	118.12
1969	3.8768	2.8571	3.7732	2.6053	1.2715	118.69
1970	6.4053	4.1667	2.6165	2.6347	3.7706	122.44
1971	-2.3616	3.0000	4.5940	3.3307	-5.6923	114.72
1972	1.1019	2.9126	4.3292	3.0473	-1.9453	111.68
1973	2.3978	-0.6289	4.4114	-0.6705	3.0683	111.73
1974	37.520	4.3354	7.9292	8.3077	29.212	146.44
1975	36.927	0.7886	10.578	2.0160	34.911	190.90
1976	13.606	13.391	27.728	89.736	-76.130	175.11
1977	7.6425	5.9183	23.880	34.155	-26.512	158.74
1978	25.714	5.9634	11.080	15.969	9.7454	185.29

Sources: Tables A.9 and H.1.

Figure 6.7 Solow's and Kendrick's Indices of Technical Change for the Distribution Sector 1960-1978

Sources: Tables 6.19 and 6.20

storage facilities. Most of these projects have been completed and the rest will be completed very shortly (Al-Eyed, 1979). For this reason very advanced technology has been imported from developed countries.

The lowest growth rate of technical change was demonstrated during the middle period when its annual growth rate declined by 1.4 per cent annually.

The technical change index as calculated by using Kendrick's methodology (see table 6.20 and figure 6.7) does not differ in its overall shape from that of Solow. As so often is the case the overall performance of the index is lower than that of Solow, with an increase in the index of 71.2 per cent between 1960-1978 or 2.73 per cent per annum. Like the result of the geometeric index the highest growth rate was reached during the last subperiod and the lowest was during the second subperiod when they were -1.42 and 2.73 per cent respectively as for the annual percentages.

One important thing to note here is that the total factor inputs increased by a very high rate. In fact it increased by 6.11 per cent per annum between 1960-1978, but inspite of that high increase, technical change increased as well, reflecting the fact that value-added growth was higher than the growth of total factor inputs.

TABLE 6.20.

Kendrick's index of technical change for the Distribution sector, 1960-1978.

year (1)	output (2)	T.F.I (3)	Kendrick's index (4)
1960	100.000	100.000	100.000
1961	118.576	107.787	110.010
1962	121.154	116.573	103.930
1963	117.850	125.449	93.9424
1964	136.794	133.521	102.451
1965	169.145	140.957	119.997
1966	177.863	147.770	120.365
1967	183.970	155.557	118.265
1968	187.743	161.478	116.265
1969	195.021	167.072	116.729
1970	207.513	172.312	120.428
1971	202.612	179.298	113.003
1972	204.845	186.208	110.009
1973	209.757	191.303	109.646
1974	288.457	204.261	141.220
1975	394.977	219.587	179.873
1976	448.716	271.201	165.455
1977	483.010	322.793	149.635
1978	607.211	354.585	171.246

Sources: Tables A.9 and H.1.

2. Direct estimate

Estimating technical change for this sector by using the indirect method seems like most time series to be defective due to the very high inter-collinearity between the explanatory variables. Simple correlation matrix shows the multicolliniarity between time on one hand and log of labour and log of capital on the other as high as 0.99 and 0.98 respectively.

From the above table we find that the variable rate of growth of technical change specification is the most proper quantification for technical change with unitary elasticity of substitution production function.

TABLE 6.21.

The direct estimate of technical change for the Distribution sector.

parameter	estimated value	standard error of the estimate	t-values
ln A	-0.79908	0.19478	-4.1 340
λ	-0.02333	0.03111	-0.74996
λ^2	0.00259	0.00180	1.43910
α	0.58878	0.52685	1.11760
$(1-\alpha)$	0.41122	———	0.78052

Method of estimation is Cochran-Orcott procedure;the sum squared of residual of the rehression is 0.13461;the coefficient of determination and Durbin-Watson statistic are 0.9674 and 1.4185 respectively.

Source table H.1.

However, although the coefficients of capital and time trend turn out to be insignificant, this specification gives a very good fit to our data. The simulated output levels are very close to that of actual levels (see table H.3 in appendix H)

6.2.8. SERVICES SECTOR

The major components in this sector are government controlled and because of their social infrastructure impact they are not usually associated with profitability and optimisation of resources. Therefore, comparing this sector with other sectors such as distribution and construction is not totally feasible within the same criteria; this is because the provision of government services, such as education and health, are available to every consumer without prejudice and up to maximum possible limits at any time at no direct cost to the consumer, whose only "contribution" is through taxation.

Technological change generated in this sector was lower than most of the other sectors because of the overall low profitability which is the major source for expansion and investment. Also goverment policy in the first place is to distribute its services as widely as possible i.e. not foremost to invest and research into the latest technical advances.

1. Indirect Estimate

The table (6.22) and figure (6.8) again show Solow's index of

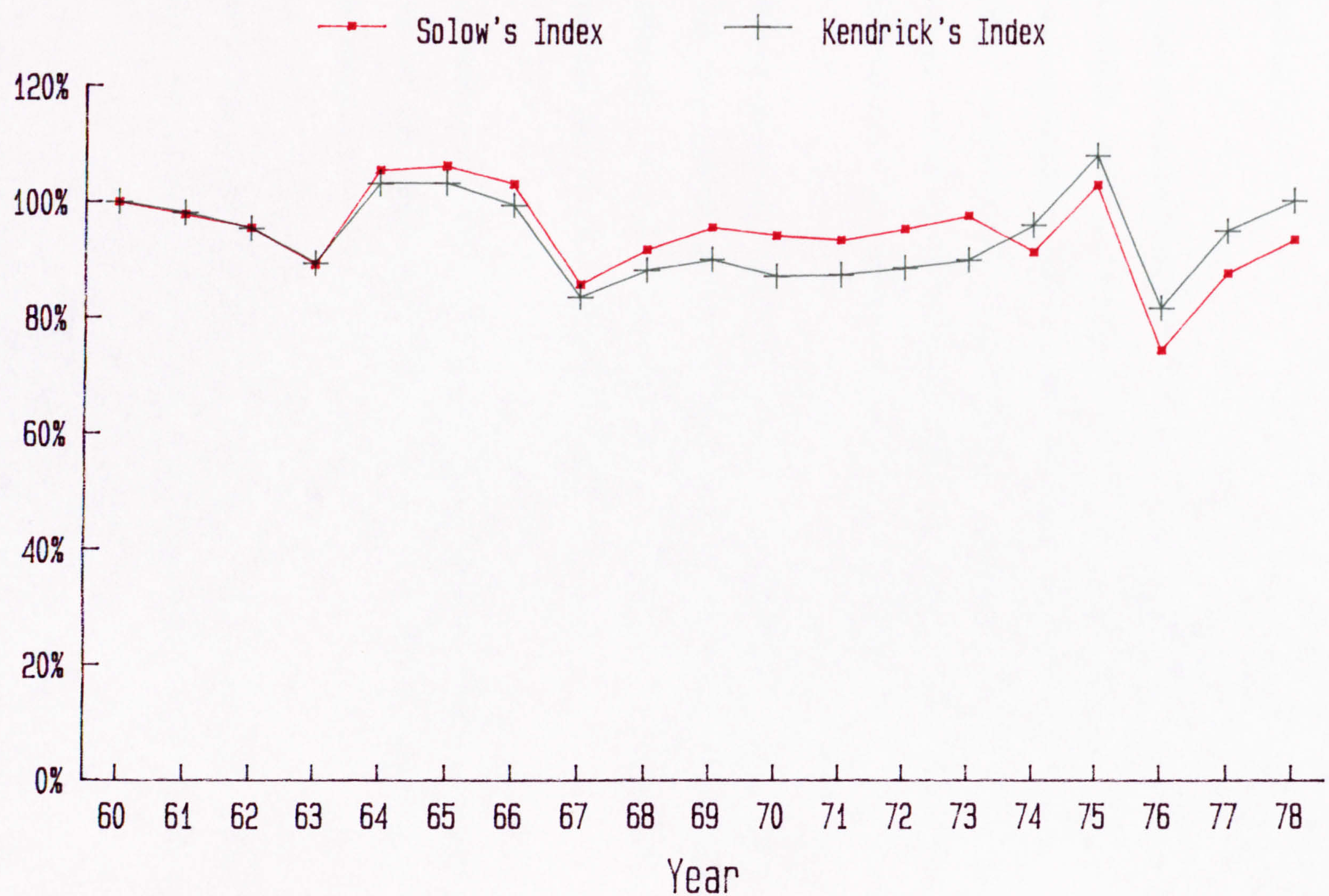
TABLE 6.22.

Solow's index of technical change for the Services sector, 1960-1978.

year (1)	ΔQ/Q (2)	ΔL/L (3)	ΔK/K (4)	ΔTFI (5)	ΔA/A (6)	Solow's index (7)
1960						100.00
1961	12.474	2.0408	19.262	7.8311	4.6431	97.941
1962	11.577	2.0000	18.916	7.5363	4.0412	95.604
1963	5.6659	1.9608	15.723	6.1416	-0.4757	89.321
1964	26.960	1.9231	11.832	4.5326	22.427	105.67
1965	10.690	1.8868	12.461	4.6838	6.0067	106.46
1966	6.4099	1.8518	12.426	4.5839	1.8260	103.25
1967	-7.7381	3.6364	11.142	8.0713	-15.809	85.796
1968	14.080	1.7544	8.9082	3.1133	10.967	91.919
1969	9.7136	1.7241	8.4052	2.8869	6.8267	94.808
1970	4.3381	1.6949	8.7151	2.9426	1.3956	94.441
1971	8.1337	3.3333	8.3008	5.5120	2.6218	93.593
1972	8.4795	3.2258	7.5036	4.8219	3.6576	95.630
1973	8.8949	3.1250	7.7813	4.8441	4.0508	97.893
1974	25.712	95.424	8.2182	156.22	-130.51	91.573
1975	27.467	25.461	10.529	53.403	-25.936	103.33
1976	-15.524	18.045	10.377	37.305	-52.826	74.390
1977	26.286	4.7115	9.4877	8.9049	17.381	87.863
1978	16.398	4.7395	11.572	10.926	5.4721	93.750

Sources: table A.9 and I.1.

Figure 6.8 Solow's and Kendrick's Indices of Technical Change for the Services Sector 1960-1978



Sources: Tables 6.22 and 6.23

technical change, this time as calculated for the services sector. The overall performance according to the index is very disappointing, since the decline in the index for the whole period was around 6.25 per cent, while the annual decline rate was 0.59 per cent. This was mainly due to:

1. The type of activities included in this sector as characterized by its small scale and the use of traditional technology in areas such as recreation, entertainment, clubs, hotels, inns, garages, stables, restaurants, hairdressers, public baths, public libraries, charitable organizations and other more specific services such as private drivers and shoe shining.

2. Inadequate investment which was due to a deliberate action on the part of the government to restrain its current and development expenditures in order to contain inflationary pressures and rationalize investment, (Al-Eyed, 1979).

3. The governement's interference in its pricing policy as applied to some of the services such as health, hotels, restaurants and hairdressers.

4. The switching around of part of the labour force from this sector to other better paid sectors such as manufacturing, construction etc.

During the first two subperiods the index' trend was downward and the overall decline during the first period was 14.2 per cent or 2.16

per cent annually. In the next subperiod the index saw a slight-up turn, its growth rate was 0.66 per cent per annum.

The last subperiod showed again a decline in the index, this time at a rate of around 0.86 per cent per annum. The disappointing performance of the index during the last subperiod might be attributed to the high increase in the investment growth rate with a high gestation period as well as the decline in the labour productivity during the years 1973-1978, which might result from the high decline in the capital output ratio (see table I.2 in appendix I).

Kendrick's index of technical change for this sector is reported in table (6.23) As has been commented on many times before this index shows only a slight difference over the one estimated using Solow's methodology. Its overall growth rate is estimated to be 0.64 per cent which amounts to 0.04 per cent per annum.

As is shown by Solow's index the lowest growth rate was noticed during the first subperiod, when it declined by 2.54 per cent annually with an overall rate of 16.5 per cent for the period. During the last subperiod this index improved substantially with an overall growth rate of 11.6 per cent and its annual rate was 2.21 per cent.

From the information provided by table 3.23 one find that the total factor inputs grew slowly during the second subperiod. This resulted from the fact that most of the investment had been directed to the commodity sectors and the "migration" of the old, trained

TABLE 6.23.

Kendrick's index of technical changefor the Services sector, 1960-1978.

year (1)	output (2)	T.F.I (3)	Kendrick's index (4)
1960	100.000	100.000	100.000
1961	112.474	114.533	98.2026
1962	125.496	131.457	95.4654
1963	132.606	148.192	89.4826
1964	168.357	162.838	103.389
1965	186.355	179.989	103.537
1966	198.300	199.154	99.5716
1967	182.956	219.030	83.5300
1968	208.716	236.256	88.3431
1969	228.990	253.942	90.1740
1970	238.924	273.752	87.2775
1971	258.357	294.805	87.6366
1972	280.264	315.439	88.8489
1973	305.194	338.315	90.2100
1974	383.664	398.376	96.3069
1975	489.046	451.116	108.408
1976	413.126	504.882	81.8262
1977	521.719	547.670	95.2615
1978	607.271	603.389	100.643

Sources: Tables A.9 and I.1.

labour force into other sectors, whilst the new labour force was drawn from the rural to the urban areas because they could not fulfill the requirements of the more "sophisticated" sectors.

2. Direct estimate

The technical change as measured by using the direct estimate is presented in table (6.24). In spite of the very high fit of the selected equation, technical change variables turn out to be insignificant. However this specification indicated the fact that the rate of growth of technical change in this sector was declining. At the same time there is no evidence that the variable rate of growth is the right specification. Furthermore the declining rate obtained by using the constant rate of growth of technical change is lower than that obtained by the indirect methodology.

TABLE 6.24.
The direct estimated of technical change for the Services sector.

parameter	estimated value	standard error of the estimate	t-values
ln A	-0.74663	0.04240	-17.6611
λ	-0.00069	0.00305	-0.22718
α	0.72239	0.05458	13.2360
$(1-\alpha)$	0.27761	———	5.08650

Method of estimation is Cochran-Orcutt prcedure; the sum squared of residual of the regression is 0.081453; the coefficient of determination and Durbin-Watson statistic are 0.980 and 2.0408 respectively.
Source: table I.1.

CHAPTER SEVEN

SOURCES OF GROWTH

7.1 INTRODUCTION

As mentioned earlier, the main objectives of this study are: first, to measure technical change, the agent of technology transfer, which is the subject of the previous chapter, and second to quantify its impact on the economic growth at aggregate and sectoral levels. It is the second part which forms the main subject of this chapter. Furthermore we will be able to indentify the different sources of growth in addition to that of technical change. Our analysis will be extended further by trying to predict the impact of the technological changes as well as that of the conventional factors of production i.e. capital and labour on predicted output for the period up to 1990.

Then we will compare the results with existing evidence on developed and developing countries*.

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* *We should point out that studies on developing countries are not manifold. However reference should be made to Corroa, H., "Sources of Economic Growth in Latin America", Southern Economic Journal Vol 37, July 1970, pp 17-31; Bruton, H., "Productivity Growth in Latin America", American Economic Review, Vol. 57, December 1967, pp 1099-1116; Chen, Edward, "Factor Input, Total Factor Productivity and Economic Growth: The Asian Case", The Developing Economies, June 1977, Vol 15, pp 121-143; Williamson, J., "Relative price changes, adjustment dynamics, and productivity growth: The case of Philippine Manufacturing", Economic Development and Cultural Change, Vol. 19, July 1971, pp*

(Footnote continued on the bottom of next page)

For the purpose of comparison we used the estimated figures on sources of growth to estimated output rather than actual figures, as they are utilized by other studies with which we would compare them. This is necessitated by the non-availability of studies on other countries which use the same method as that adopted by this study.*

7.2. WHOLE ECONOMY

As we have seen in the previous chapter, the best estimate has been obtained by using the variable rate of growth of technical change, specifically the variable and continous specification, therefore this equation is also used in estimating output as well as in finding the contributions that have been made by the different components.

(Footnote continued)

507-526; Williamson, J., "Dimensions of Philippine Post-War Economic Progress", Quarterly Journal of Economics, February 1969, Vol 83, pp 93-109; Bakul, Dholakia H., "The Sources of Economic Growth in India", Good Companions,Baroda, 1974; Ballassa, Bela, et al: "Growth Performance of Eastern European Economies and Comparable Western European Countries", American Economic Review, Vol 60, 1970, pp 314-321; MaCarthy F.D. et al: "Sources of Growth in Colombia 1963-1980", Journal of Economic Studies, Vol. 12 (4), 1985, pp 3-14.

* *The difference between other methods and the one adopted by this study is that the former estimate g_A in equation 5.47 as a residual rather than using the econometric method to estimate it. Further when the estimated output equal to actual one there should be no difference between them.*

TABLE 7.1.

Sources of growth for the Whole Economy, 1960-1978 and subperiods.

	1960-67	1968-72	1973-78	1960-78
actual output growth rate	6.7944	3.3165	16.433	7.7459
estimated output growth rate	7.3618	6.9650	16.055	8.8399
labour growth rate	4.6861	3.6512	3.1661	3.9127
capital growth rate	10.085	6.9369	13.914	9.0246
share of labour	0.1189	0.1189	0.1189	0.1189
share of capital	0.8811	0.8811	0.8811	0.8811
weighted labour growth rate	0.5571	0.4341	0.3764	0.4652
weighted capital growth rate	8.8860	6.1122	12.260	7.9517
total factor inputs growth rate	9.4431	6.5463	12.636	8.4169
technical change growth rate	-2.0813	0.4187	3.4187	0.4230
sources of growth as a percentage of output growth				
labour	7.5674	6.2328	2.3444	5.2625
capital	120.70	87.756	76.363	89.952
total factor inputs	128.27	93.989	78.707	95.215
technical change	-28.272	6.0115	21.294	4.7851
total	100.00	100.00	100.00	100.00

Notes: In this table and the subsequent similar tables (1) the estimates of growth rate of output, labour and capital are obtained by fitting an exponential trend to the annual estimates of the variables,(2) Rate of growth of technical change for the whole period calculated as average of three subperiods

Sources: tables 6.3., B.1. and B.5.

Table 7.1 gives the annual growth rate of output, capital and labour, the estimated output shares of capital, labour and technical change in relation to the growth of output. The estimated output growth rates are derived by using equation (5.47), while the contribution of input i is simply its weighted growth rate divided by estimated output growth rate in percentage.

Figures show that the growth rate is higher in 1960-1967 than in 1968-1972, and increasing sharply during the 1973-1978 subperiod. Furthermore, capital input is the major contributor to growth of output. Technical change, on the other hand is an increasingly important source of growth.

A careful look at table 7.1 shows that the implication of the esimates does follow actual occurences fairly well with the exception of the 1968-1972 subperiod. Further the following points are permited:

1 Real Gross Domestic Product had declined during the 1968-1972 subperiod, this might be because of under utilization of resources and high investment in infrastructure. During the last subperiod, 1973-1978, Gross Domestic Product increased sharply; its annual growth rate was more than 16 percentage points.

2 The growth in Gross Domestic Product during 1960-1972 is largely explained by the contribution of total factor inputs. In fact during the 1960-1967 subperiod growth rates of total factor

resulted in a negative contribution from technical change. In contrast to this during the last period technical change became an important contributer to growth of productivity.

3 It seems that the slowdown in the GDP during the first subperiod was caused mainly by the decline in the rate of technical change, while the decline in the second subperiod might be attributed to the low growth rate of technical change and the high decline in the total factor inputs, which consisted mostly of capital input.

4 According to our results the Iraqi pattern of development is based mainly (up to 1972 anyway) on input factors usage rather than technical change increments.

5. It seems that sustaining a high growth rate in GDP will be possible as long as capital keeps growing at a high rate. On the other hand the rate of technical change will continue in its importance at an increasing rate.

What is now the potential contribution of technical change as well as that of total factor inputs in relation to output figures, for the economy as a whole during the period 1979-1990 ?

For this purpose we predicted the output levels for the period 1979-1990 by the mean of the results in table 6.3, and by assuming that capital and labour continue to grow at the same rate as those of 1973-1978.

In table 7.2 we gather the projected growth rates of output with those of technical change along with the percentage contributions made by technical change during the subperiods 1979-1982, 1983-1986, and 1987-1990.

According to our projection output will have grown in by 1990 by more than 9 times its level in 1978 (see table B.4 in appendix B). Technical change contribution would increase from 21.3 per cent in the 1973-1978 subperiod to 34.0 per cent in the 1987-1990 subperiod. In contrast to this the contribution of total factor inputs, which is calculated as a residual, would decline from 78.7 per cent in the 1973-1978 subperiod to 66.0 per cent in 1987-1990 subperiod.

TABLE 7.2.

Projected sources of growth for the ecocomy as a whole, 1979-1990

	1979-1982	1983-1986	1987-1990
growth of output	18.360	20.717	23.122
	(100.00)	(100.00)	(100.00)
growth of technical change	4.8976	6.3766	7.8555
	(26.675)	(30.780)	(33.974)
residual	13.462	14.340	15.267
	(73.325)	(69.220)	(66.028)

Note: In this table and the subsequent similar tables the figures in brackets indicate the percentage distribution of the figures above it.

Sources: Table B.4 in appendix B.

The contribution of technical change to output would vary from 26.7 per cent in 1979-1982 to 34.0 per cent in 1987-1990. Further, the contribution due to technical change would increase even further if we were to assume that capital and labour grows at lower rates.

In the next stage the contribution of technical change as well as that of total factor inputs to the growth of GDP will be compared to other studies. This comparison should reflect the performance of those factors during the period under study relative to the performance of these factors in other countries.

From the figures in table (7.3) the contribution of technical change to the growth rate of output vary considerably, from a low rate or negative one of 42.8 for the USSR during the 1976-1980 subperiod to 62.3 in Hong Kong during the period 1966-1970. With respect to the Iraqi economy, this contribution was very low compared to that of other countries during the first and second subperiods. During the last subperiod this contribution looks very impressive as compared to the rates of previous subperiods. Further, this rate is still low in comparison to the rapidly growing Asian countries such as Japan , Hong Kong etc.

Other important points can be drawn from the figures in table 7.3. Firstly the high increase in total factor inputs in Iraq. This reflects the high investment that took place during the period under study. Secondly, the high annual growth rate of GDP especially during the last subperiod. In fact both growth rates, that of GDP and of total factor inputs, are higher than anywhere else.

TABLE 7.3.

Contribution of technical change and total factor inputs to growth of output in the Whole Economy for Iraq and selected countries.

		annual % of change of			% of output explained by	
country	period	output	tfi	tc	tfi	tc
Iraq	1960-67	7.36	9.44	-2.08	128.	-28.3
	1968-72	6.97	6.55	0.42	94.0	6.00
	1973-78	16.1	12.6	3.42	78.6	21.3
	1960-78	8.84	8.42	0.42	95.2	4.78
Colombia	1963-67	4.88	4.21	0.67	86.3	13.7
	1967-74	6.68	4.61	2.07	69.1	31.0
	1974-78	5.59	5.56	0.03	99.5	1.50
	1963-80	5.73	4.95	0.77	86.5	13.5
Hong Kong	1960-66	10.6	6.30	4.27	59.6	40.4
	1966-70	6.90	2.60	4.30	37.7	62.3
	1955-70	9.31	4.98	4.33	53.5	46.5
Korea	1960-66	6.91	2.80	4.10	40.7	59.3
	1966-70	10.1	5.05	5.06	49.9	50.1
	1955-70	8.84	3.85	4.99	43.6	56.4
Japan	1960-66	8.94	4.94	4.00	55.3	44.7
	1966-70	12.0	4.60	7.44	38.2	61.8
	1955-70	10.12	4.54	5.58	44.9	55.1
U.S.S.R	1961-65	5.02	4.72	0.30	94.0	5.98
	1966-70	5.25	4.41	0.84	84.0	16.0
	1955-70	3.70	4.47	-0.77	120.	-20.8
	1976-80	2.71	3.81	-1.16	142.	-42.8

Notes: In this table and the following similar tables tfi = total factor inputs and tc = technical change

Sources:

Figures on Colombia from McCarthy, F. D., et al 1985.
Figures on Hong Kong,Korea and Japan from Chen, E. 1977.
Figures on U.S.S.R from Levine, Herbert, et al 1983.

7.3. AGRICULTURAL SECTOR

The calculated contributions of total factor inputs and its two components, viz, labour and capital as well as the contribution of technical change to the growth of value-added in the agricultural sector during the period 1960-1978 are given in table 7.4.

According to our estimate the value-added shows a declining trend; it declined from 4.24 percent per year in 1960-67 to 3.79 percent in 1968-72 and even further to -1.93 in 1973-78. Furtermore, the growth rate obtained for the overall period is disappointing when it is compared to the impressive rate of growth reached in the overall economy.

The total factor inputs growth rate declined from 6.12 percent per year between 1960 and 1967 to -0.05 percent per year between 1973 and 1978. This was caused mainly by the sharp decline in the labour force as a result of the migration to the modern sectors. This is in contrast to the capital growth rate which increased by as much as 10.3 during the 1973-1978 subperiod compared to 5.06 percent during the 1960-67 subperiod.

The technical change contribution declined throughout the period studied. In fact, our finding shows that it is the only factor responsible for the output retardation during the first and second subperiods, while the slow-down in the growth of output during the 1973-78 subperiod was caused by the decline of both technical change and that of labour input. Thus a large proportion of the contribution

TABLE 7.4.

Sources of growth for the Agricultural sector, 1960-1978 and subperiods.

	1960-67	1968-72	1973-78	1960-78
actual output growth rate	6.8509	2.0909	3.6007	2.2665
estimated output growth rate	4.2414	3.7876	-1.9296	2.3536
labour growth rate	7.0073	4.1950	-8.6264	2.0961
capital growth rate	5.0589	7.4415	10.268	6.8071
share of labour	0.5460	0.5460	0.5460	0.5460
share of capital	0.4540	0.4540	0.4540	0.4540
weighted labour growth rate	3.8260	2.2905	-4.7100	1.1445
weighted capital growth rate	2.2967	3.3784	4.6617	3.0904
total factor inputs growth rate	6.1227	5.6689	-0.0483	4.2349
technical change growth rate	-1.8813	-1.8813	-1.8813	-1.8813
sources of growth as a percentage of output growth				
labour	90.206	60.474	-244.09	48.628
capital	54.150	89.196	241.59	131.31
total factor inputs	144.36	149.67	-2.5031	179.93
technical change	-44.360	-49.670	-97.497	-79.930
total	100.00	100.00	100.00	100.00

Notes: as of table 7.1.

Sources: tables 6.6, C.1 and C.5.

of capital input went to compensate the decline in the contributions of technical change and labour.

Finally it is fair to mention that our model, although it succeeded in estimating the over-all growth rate very well, it failed to estimate the growth rate of output, especially for the last subperiod. In fact our model gives a high declining rate of technical change which resulted in a high discrepancy between the observed and estimated output. However, no doubt this resulted from the crude nature of the data utilised.

As to the expected contribution which could be made by technical change during the period 1979-1990, we have to take into account the fact that technical change is one major factor of retardation of output during the period 1960-1978. Its future contribution therefore is assumed to remain negative and it is envisaged that it will continue to affect the growth of output during the 80's.

Therefore output would continue to decline and technical change is the most likely cause of this decline. In fact, our estimate shows (see table 7.5) that output is anticipated to decline by an annual rate of 2.33 percent, and of that decline technical change would be responsible for more than 80 percent. Total factor inputs contribution would decline too, as a result of labour force migration to modern sectors. However, it seems, according to our analysis that achieving a high growth rate in the Agricultural sector must be associated with high growth of total factor inputs, particularly investment since labour would continue to decline for the time

TABLE 7.5.
Projected sources of growth for the Agricultural sector, 1979-1990.

	1979-82	1983-86	87-1990
Growth of output	-2.3300	-2.3327	-2.3344
	(100.00)	(100.00)	(100.00)
Growth of technical change	-1.8813	-1.8813	-1.8813
	(-80.45)	(-80.65)	(-80.59)
Residual	-0.44870	-0.45140	-0.4531
	(-19.26)	(-19.35)	(-19.41)

Sources: tables 6.6 and C.4.

being.

If we rely on the assumption that capital input continues to increase at the rate of the 1973-78 subperiod, and labour continues to decline at the rate it was during that same subperiod, and we assume that capital grows by half that rate and labour declines at twice the rate, then the picture will undoubtedly worsen still more than has been explained so far. In fact, according to the latter assumption output would decline at 10.0 percent per annum between 1983 and 1986, and by 5.3 percent per annum between 1987 and 1990. Of this decline, technical change would be responsible for 18.8 percent during the 1983-86 subperiod and expanding to 35.5 percent during the 1987-1990 subperiod.

The main conclusion that can be drawn is that in order to offset the declining rate of technical change, total factor inputs must increase at a higher rate and this would keep the development of this sector as an input factor usage one.

A comparison of the contributions of technical change and of total factor inputs made to growth of agricultural output in Iraq as compared to that of some other countries is reported in table 7·6.

From the information in table 7.6 we can draw the following conclusions:

First, in most countries technical change plays an important role in the growth of agricultural output. In fact it explains even more than 100 percent of the increase of the Japanese agricultural output, offsetting the negative contribution of total factor inputs. While in the Iraqi agricultural sector the technical change contribution to the growth of output is very negative and declining with time, in spite of the high growth rate of labour and capital inputs during the first and the second subperiods and capital during the last subperiod.

Second, in all of the countries, except Japan and Korea, both contributions of total factor inputs and of technical change vary considerably. This might be caused by the existence of uncontrollable factors, such as the weather etc.

table 7.6.

Contribution of technical change and total factor inputs to growth of output in the agricaltural sector for Iraq and selected countries.

		annual % of change of			% of output explained by	
country	period	output	tfi	tc	tfi	tc
Iraq	1960-67	4.24	6.12	-1.88	144.	-44.4
	1968-72	3.79	5.67	-1.88	149.	-49.7
	1973-78	-1.93	-0.05	-1.88	-2.50	-97.5
	1960-78	2.35	4.23	-1.88	180.	-80.0
Pakistan	1960-65	4.70	3.90	0.80	83.0	17.0
	1965-70	8.20	1.30	6.90	15.9	84.1
	1970-75	0.50	2.10	1.60	420.	-320.
	1965-79	3.70	1.70	2.00	45.9	54.1
Taiwan	1960-66	6.15	2.85	3.30	46.3	53.7
	1966-70	0.85	2.38	0.32	280.	-180.
	1955-70	3.75	2.55	1.20	68.0	32.0
Korea	1960-66	6.94	1.35	5.59	19.5	80.5
	1966-70	5.03	1.47	3.56	29.2	70.8
	1955-70	4.75	1.41	3.34	29.7	70.3
Japan	1960-66	3.97	-0.03	4.00	-1.00	101.
	1966-70	4.19	-1.28	5.47	-30.0	130.
	1955-70	3.85	-0.39	4.24	-10.0	110.
U.S.S.R	1960-71	3.00	2.10	1.00	70.0	30.0
	1971-79	1.80	1.60	0.20	88.9	11.1

Sources:

Figures on Pakistan from Shahida, W, 1981.
Figures on Taiwan,Korea and Japan from Chen, E, 1977.
Figures on U.S.S.R from Diamond, H, et al 1983.

7.4. MANUFACTURING SECTOR

Calculation of sources of growth in the manufacturing sector during the period 1960-78 and subperiod are presented in table 7.7. The figures show that the implication of the estimates do not follow actual occurences very well. This might be due to the high variation in the growth rate of output achieved in the different subperiods.

For the overall period, manufacturing output increased at an annual rate of 11.6 percent. Furthermore, growth is more stable, but there was a stronger tendency for an increase at a higher rate during the last subperiod. In fact a very impressive rate of growth was achieved during the last subperiod of 21.9 percent per annum according to the estimated rate of growth of output and 23.6 per cent according to the actual figures on output.

The average rate of growth of technical change increases with time. Thus the contribution made by technical change increased from negative 43.5 percent during the first period to 38.3 percent during the last subperiod. During the 1960-67 subperiod, the increase in total factor inputs was higher than the growth rate of output, this resulted in a negative contribution from technical change. Increases in capital appear to have been absolutely and relatively more important than labour.

During the second subperiod technical change growth turned positive and was responsible for around 22.8 percent of the growth of output. Although the contribution of labour accelerated, it remained

TABLE 7.7.

Sources of growth for the Manufacturing sector, 1960-1978 and subperiods.

	1960-67	1968-72	1973-78	1960-78
actual output growth rate	3.6196	8.6296	23.609	10.033
estimated output growth rate	5.5213	11.010	21.934	11.583
labour growth rate	1.2006	6.0752	7.2939	4.0445
capital growth rate	10.522	9.4344	15.929	11.145
share of labour	0.2787	0.2787	0.2787	0.2787
share of capital	0.7213	0.7213	0.7213	0.7213
weighted labour growth rate	0.3346	1.6932	2.0328	1.1272
weighted capital growth rate	7.5895	6.8050	11.490	8.0389
total factor inputs growth rate	7.9241	8.4982	13.523	9.1661
technical change growth rate	-2.4028	2.5122	8.4102	2.4170
Sources of growth as a percentage of output growth				
labour	6.0602	15.379	9.2678	9.7315
capital	137.46	61.807	52.284	69.403
total factor inputs	143.52	77.186	61.653	79.134
technical change	-43.520	22.817	38.346	20.867
total	100.00	100.00	100.00	100.00

Notes: As of table 7.1.

Sources: table 6.9 D.1 and D.5.

far less significant than the contribution of capital.

During the last subperiod, the technical change contribution increased sharply. It contributed to about 38.3 percent of the rate of growth of output. Whereas labour's contribution was less than that of the 1968-72 subperiod.

Table 7.7 suggests that, for both the first set of subperiods, increases in the manufacturing output appear to be largely associated with increases in total factor inputs especially capital, while for the last subperiod increases in output had a lot to do with the increases in technical change.

Predicted technical change contribution to the growth of output during the period 1979-1990 are shown in table 7.8

From the figures in the table, output in the manufacturing sector will continue to increase at an impressive growth rate during the 80's. The output growth rate will jump from 27.7 percent per annum over 1979-82 to 38.2 percent per annum over 1987-90.

Technical change as intput would continue to increase at the rate of 11.4 percent in 1979-82 to 17.3 percent per annum in 1987-90. At the same time its contribution to the growth of output would increase from 41.0 percent in 1979-82 to 45.2 percent in 1987-90. In fact these impressive contributions of technical change are even higher than that of Japan during the period 1955-70, which was 38.4 percent (see table 7.9).

Based on the second assumption about the growth rate of input factors utilized and of the total factor inputs growth rate declines, technical change contributions will increase to more than 70 percent

TABLE 7.8.

Projected sources of growth for the Manufacturing sector, 1979-1990.

	1979-82	1983-86	1987-90
Growth of output	27.708	32.835	38.159
	(100.00)	(100.00)	(100.00)
Growth of technical change	11.359	14.309	17.258
	(40.995)	(43.578)	(45.227)
Residual	16.349	18.526	20.901
	(59.005)	(56.422)	(54.773)

Sources: Tables 6.9 and D.4.

during the 1983-86 subperiod and to 50.8 percent in 1987-90 subperiod.

A comparison of the sources of growth in the Iraqi manufacturing sector to international data is shown in table 7.9. However, before we comparing the results, we can ask how the information might be useful. First, among the ten countries in the table, the most advanced two countries, i.e. U.S.A. and U.K. showed the lowest growth rate of total factor inputs, and they went on to obtain a rate of growth of value-added equal to 4.3 and 3.8 respectively. This means that the contribution of technical change must be higher than that of other countries. In fact no country has managed to obtain the high growth rate achieved by the U.K. during the period 1950-1973, which

table 7.9

Contribution of technical change and total factor inputs to growth of output in the manufacturing sector for Iraq and selected countries.

		annual % of change of			% of output explained by	
country	period	output	tfi	tc	tfi	tc
Iraq	1960-67	3.62	7.92	-2.41	143.	-43.5
	1968-72	8.63	8.50	2.51	77.2	22.8
	1973-78	23.6	13.5	8.41	61.7	38.3
	1960-78	11.6	9.17	2.42	79.1	20.9
Korea	1960-66	12.4	9.82	2.62	78.9	21.1
	1966-70	14.7	9.92	4.77	67.5	32.5
	1960-70	13.8	10.7	3.08	77.7	22.3
Taiwan	1960-66	9.89	6.09	3.80	61.6	38.4
	1966-70	14.1	10.8	3.28	76.7	23.3
	1955-70	11.5	6.94	4.58	60.2	39.8
Japan	1960-66	7.92	6.53	1.39	82.5	17.6
	1966-70	13.7	6.78	6.97	49.3	50.7
	1955-70	11.5	7.06	4.40	61.6	38.4
China*	1957-65	10.3	11.7	-1.40	113.	-13.6
	1965-78	9.10	8.30	0.80	92.2	8.79
	1957-83	8.70	8.90	-0.20	102.	-2.30
Brazil**	1960-74	7.30	5.70	1.60	73.1	21.9
India	1960-79	6.24	6.42	-0.18	102.	-2.90
U.S.S.R**	1961-65	6.59	6.85	-0.26	104.	-3.95
	1966-70	6.28	5.75	0.52	92.0	8.25
	1971-75	5.91	4.88	1.03	82.6	17.4
	1976-80	3.43	4.33	-0.90	126.	-26.2
U.K	1960-73	3.80	1.80	2.10	44.7	55.3
U.S.A	1960-73	4.30	3.00	1.30	69.8	30.2

Notes:
* The study coverd state ownedindustry only.
** The study coverd whole industrial sector.

Sources:
Figures on China, Brazil, India, U.K and U.S.A from Gene 1986.
Figures on Taiwan,Korea and Japan from Chen 1977.
Figures on U.S.S.R from Weitzman 1983.

was mostly achieved by enhancing technical change. Second, the contribution of technical change (excluding the U.S.S.R.) is connected to the level of development. This can be seen if we compare these contributions for the early periods.

When we compare the sources of growth in the Iraqi manufacturing sector to those ten countries we found the following:

1 Iraq could not achieve high contributions to technical change compared to the growth rate of output during the first subperiod.

2 During the last subperiod, the contribution of technical change was rather higher than that of many other countries. This is because (a) a large part of investment took place in the first and second subperiod which only became productive during the last subperiod and (b) investment in this sector mostly took place in the form of highly advanced technology.

3 The contribution of total factor inputs to growth was declining with time. This suggests that Iraq started reaping the benefit from the technology transferred to it.

7.5. MINING AND QUARRYING SECTOR

The estimated contribution of the two input factors as well as of technical change in the estimated growth rate of output is shown in table 7.10. Although our estimate tracks output growth very well for

TABLE 7.10.

Sources of growth for the Mining and Quarrying sector, 1960-1978 and subperiods.

	1960-67	1968-72	1973-78	1960-78
actual output growth rate	4.0482	n.s*	14.457	6.3096
estimated output growth rate	5.0139	3.6616	18.384	6.4164
labour growth rate	4.0190	3.8546	17.687	6.1298
capital growth rate	7.2421	3.2268	19.944	7.0567
share of labour	0.6915	0.6915	0.6915	0.6915
share of capital	0.3085	0.3085	0.3085	0.3085
weighted labour growth rate	2.7791	2.6655	12.231	4.2388
weighted capital growth rate	2.2342	0.9955	6.1527	2.1770
total factor inputs growth rate	5.0130	3.6610	18.384	6.4158
technical change growth rate	0.0006	0.0006	0.0006	0.0006
sources of growth as a percentage of output growth				
labour	55.428	72.796	66.531	66.062
capital	44.560	27.188	33.468	33.929
total factor inputs	99.982	99.984	99.998	99.991
technical change	0.0120	0.0164	0.0033	0.0094
total	100.00	100.00	100.00	100.00

Notes: as of table 7.1. and * stands for not significant
Sources: table 6.12 E.1 and E.5.

the overall period, it fails to follow the changes during the different subperiods. A problem with this estimate is the low share of capital, which was probably caused by the low movement in the capital stock series, especially between 1963 and 1970.

However our estimate shows an increasing trend of the output growth rate, especially during the last subperiod. The disappointing points in our estimate are the low contribution made by technical change and the high contribution assigned to labour which should not be the case in a sector characterised by intensive technology. Furthermore, since capital is growing faster than labour, assigning high shares of capital resulted in a decline in the contribution of technical change.

However, some interesting points can be made regarding the figures in table 7.10.

1 The contribution of total factor inputs outweighed the contribution of technical change .throughout the period under study, and in fact it was always higher than 99 percent.

2 During the 1968-72 subperiod, capital contribution declined by one half as a result of a sharp decline in the capital growth. This together with the low growth of technical change left labour as the major contributor. However, in the latter subperiod the contribution of capital increased and alternatively that of labour decreased.

3 The retardation of output growth during the second subperiod resulted from a sharp decline of the input factors and the inability of technical change to offset that decline. However, the output growth in this sector was affected by many other factors and not only those under consideration.

The projected contributions of technical change to the projected output of the mining and quarrying sector for the period 1979-90 can be found in table 7.11.

TABLE 7.11.
Projected sources of growth for the Mining and quarrying sector, 1979-1990.

	1979-82	1983-86	1987-90
Growth of output	18.417	18.446	18.435
	(100.00)	(100.00)	(100.00)
Growth of technical change	0.0006	0.0006	0.0005
	(0.0033)	(0.0033)	(0.0033)
Residual	18.416	18.445	18.434
	(99.997)	(99.997)	(99.997)

Sources: Tables 6.12 and E.4.

Our projection leaves no role for technical change in the growth of output in this sector. In a sector characterised as highly capital intensive, one would expect technical change to play a very important role. However, since the oil market is a demand side rather than a supply side market thus, is not unusual to end up with a result such as ours.

For purposes of comparison, not too many estimates exploring the sources of growth in the mining sector are found. However, table 7.2 shows a comparison of our results with the results of the Japanese mining sector.

Table 7.12.

Contribution of technical change and total factor inputs to growth of output in the Mining and quarrying sector for Iraq and Japan.

		annual % of change of			% of output explained by	
country	period	output	tfi	tc	tfi	tc
Iraq	1960-67	5.014	5.013	0.0006	99.98	0.012
	1968-72	3.662	3.661	0.0006	99.98	0.016
	1973-78	18.38	18.38	0.0006	100.0	0.003
	1960-78	6.416	6.416	0.0006	99.99	0.009
Japan	1955-71	5.820	2.010	3.810	34.50	65.46

Sources:
Figures on Japan from Nishimizu 1978.

7.6. ELECTRICITY, GAS AND WATER SECTOR

The results for this sector are worse than those for any other, the most notable fact about these figures (see table 7.13) is that both growth rates of total factor inputs and outputs are varied widely. The selected equation failed to capture the high variation in the actual output figures and this resulted in a high discrepancy between actual and estimated figures. The electricity sector is generally a high growth sector with a very rapid growth of capital input. The rapid growth in electricity reflects the attempts to increase the availability of electric power to increase industrialisation as well as to meet the willingness of the government to increase the infrastructure.

However, a closer look at table 7.13 enables us to make the following comments:

1. During the whole period, 1960-78, total factor inputs contributed 89.8 percent to the rate of growth of value added in this sector, leaving only 10.2 percent as the contribution made by the increase in technical change. Further, the contributions made by these factors do not differ considerably from period to period.

2. Among the two input factors, capital contributed the largest part during the overall period as well as the individual subperiods, whilst the contribution from labour was relatively low.

3. If the contribution of technical change is calculated as a residual, technical change would contribute by more than 47.9 per cent in the first subperiod and by more than 40.6 per cent in the last subperiod, this implies that around 60 per cent was left for total factor inputs to contribute. In fact this point is not shown by our estimate as a result an underestimate of the output growth rates in this sector during the over all period as well as the first and second subperiods.

Table 7.13

Sources of growth for the Electricity, Gas and Water sector, 1960-1978 and subperiods.

	1960-67	1968-72	1973-78	1960-78
actual output growth rate	20.745	n.s*	18.940	10.141
estimated output growth rate	11.812	7.4829	12.269	9.9323
labour growth rate	0.5631	3.1501	10.202	3.9592
capital growth rate	15.116	7.8719	11.702	11.013
share of labour	0.2966	0.2966	0.2966	0.2966
share of capital	0.7034	0.7034	0.7034	0.7034
weighted labour growth rate	0.1670	0.9343	3.0259	1.1743
weighted capital growth rate	10.633	5.5371	8.2312	7.7465
total factor inputs growth rate	10.800	6.4714	11.257	8.9208
technical change growth rate	1.0115	1.0115	1.0115	1.0115
Sources of growth as a percentage of output growth				
labour	1.4138	12.486	24.663	11.823
capital	90.019	73.997	69.089	77.993
total factor inputs	91.432	86.483	91.752	89.816
technical change	8.5633	13.517	8.2444	10.184
total	100.00	100.00	100.00	100.00

Notes:
* n.s stands for not significant and other notes as in table 7.1.
Sources: table 6.15 F.1 and F.5.

In order to demonstrate technical change contributions that could be made during the subperiods 1979-82, 1983-86 and 1987-90, projected output and technical change growth rates along with the percentage contributions are reported in table 7.14.

TABLE 7.14.

Projected sources of growth for the Elecricity, gas and water sector, 1979-1990.

	1979-82	1983-86	1987-90
Growth of output	12.522	12.550	12.542
	(100.00)	(100.00)	(100.00)
Growth of technical change	1.6015	1.6015	1.6015
	(12.789)	(12.761)	(12.691)
Residual	10.921	10.949	10.9416
	(87.211)	(87.239)	(87.231)

Sources: Tables 6.3 and E.4.

As can be seen from the table above, technical change contributions in the different subperiods remain constant. This means the growth of output will depend mainly on the growth of the conventional inputs. Thus by assuming lower growth rate to capital and labour, total factor inputs growth will decline and a large contribution to technical change will be assigned.

For purpose of comparison we are at disadvantage in not having another study at a similar type. However, table 7.15 contains a comparison of our results with those of another study. Comparing our figures with those of Japan shows that in both countries the largest contribution was made by total factor inputs. Technical change

table 7.15

Contribution of technical change and total factor inputs to growth of output in the Electricity, gas and water sector for Iraq and Japan.

		annual % of change of			% of output explained by	
country	period	output	t.f.i	tc	tfi	tc
Iraq	1960-67	11.8	10.8	1.01	91.4	8.56
	1968-72	7.48	6.47	1.01	86.5	13.5
	1973-78	12.3	11.3	1.01	91.7	8.23
	1960-78	9.93	8.92	1.01	89.8	10.2
Japan	1955-71	11.4	9.28	2.15	81.2	18.8

Sources:
Figures on Japan from Nishimizu 1978.

contribution to output in both countries is limited to less than 20 percent, although in Iraq it was even lower for the overall period.

7.7. CONSTRUCTION SECTOR

The calculation of the various sources of growth in the construction sector are shown in table 7.16, which reveal that technical change has been relatively more important in the growth of this sector than in the cases of the whole economy and the manufacturing sector, for the overall period. It is the most important contributor to growth in the 1968-72 subperiod when its contribution exceeded that of total factor inputs. The lowest contribution was made during the first subperiod when it was as low as 29.8 percent, and its highest contribution was during the second subperiod .

TABLE 7.16.

Sources of growth for the construction sector, 1960-1978 and subperiods.

	1960-67	1968-72	1973-78	1960-78
actual output growth rate	5.6361	2.9185	42.725	11.658
estimated output growth rate	4.9441	9.7944	34.964	13.021
labour growth rate	2.1119	1.7931	22.832	5.6694
capital growth rate	7.9586	10.434	25.908	11.906
share of labour	0.7677	0.7677	0.7677	0.7677
share of capital	0.2323	0.2323	0.2323	0.2323
weighted labour grwth rate	1.6213	1.3766	17.528	4.3486
weighted capital growth rate	1.8488	2.4238	6.0184	2.7656
total factor inputs growth rate	3.4701	3.8004	23.546	7.2953
technical change growth rate	1.4740	5.9940	11.418	5.7261
sources of growth as a percentage of output growth				
labour	32.793	14.055	50.132	33.397
capital	37.394	24.747	17.213	21.240
total factor inputs	70.187	38.802	67.344	56.027
technical change	29.813	61.198	32.656	43.976
total	100.00	100.00	100.00	100.00

Notes: as of table 7.1.

Sources: table 6.18, G.I and G.4.

Output growth is relatively unstable with a strong tendency to rise during the period 1973-78. In fact the growth rate achieved in this sector during this period is higher than that of the economy and all its sectors.

Among the two input factors, capital input contribution was the largest in the first two subperiods while that of labour was the highest in the last one, as well as for the overall subperiod. However, the contribution of capital input was affected very much by the low estimated share of capital in output. Another noticeable point is that the technical change in this sector has been of the labour usage type since 1973, this is clear from the increasing contribution of labour to output.

Finally, it seems that the decline in the value-added during the second subperiod was a result of the sharp decline in the contribution of labour and of capital, whilst in spite of the high decline in the contribution of capital input a high rate of growth in output was achieved during the last subperiod as a result of the high contribution of labour input.

In order to examine the role expected to be played by technical change in the growth of the construction sector's output, the projected growth rate of both output and technical change during the periods 1979-90 are presented in table 7.17 below.

As that obtained for the period 1973-78, output in this sector continues to increase at a very impressive rate. In fact if all the circumstances are the same output will increase by more than 40 percent per annum. Output in absolute terms by 1990 will be more than 60 times that of 1979. The contribution made by technical change to output growth will increase from 32.9 percent over the period 1979-82 to 36.5 percent in the 1987-90 period.

TABLE 7.17.

Projected sources of growth for the Construction sector, 1979-1990

	1979-82	1983-86	1987-90
Growth of output	42.879	48.131	53.599
	(100.00)	(100.00)	(100.00)
Growth of technical change	14.127	16.836	19.546
	(32.946)	(34.980)	(36.467)
Residual	28.752	31.295	34.053
	(67.054)	(65.020)	(63.533)

Sources: Tables 6.18 and G.4.

The projected contribution of technical change is even higher than that stated in table 7.17 if we assume that labour and capital wil grow by less than their growth rates in the 1973-78 subperiod.

When the results are compared with those of other countries (see table 7.18) one can observe the following:

1 The growth rate of value-added in Iraq is by far higher than those achieved in the U.S.S.R. In fact its amounted to 13 per cent overall the period 1960-1978 compared to an average rate of 4.72 per cent in the U.S.S.R. over the period 1961-1980, while it is slightly less than that for Japan for the period 1955-1971.

table 7.18
Contribution of technical change and total factor inputs to growth of output in the construction sector for Iraq and selected countries.

		annual % of change of			% of output explained by	
country	period	output	tfi	tc	tfi	tc
Iraq	1960-67	4.94	3.47	1.47	70.2	29.8
	1968-72	9.79	3.80	5.99	38.8	61.2
	1973-78	35.0	23.5	11.4	67.3	32.7
	1960-78	13.0	7.30	5.72	56.0	44.0
Japan	1955-71	14.3	14.5	-0.20	101.	-1.40
U.S.S.R	1961-65	5.04	3.47	1.57	70.0	30.0
	1966-70	5.82	6.18	-0.36	88.9	11.1
	1971-75	5.62	4.47	1.15	70.0	30.0
	1976-80	2.38	2.78	-0.40	88.9	11.1

Sources:
Figures on Japan from Nishimizu 1978.
Figures on U.S.S.R from Levine et al 1983.

2 On average technical change contribution to the Iraqi construction sector is higher than that of the U.S.S.R. and that

of Japan which had a negative one.

3 The high increase in the total factor inputs in the Iraqi construction sector is accompanied by a high growth rate of value-added. This is most likely a result of the highly advanced production technology used in this sector.

7.8. DISTRIBUTION SECTOR

The contribution of the different sources of growth to the rate of growth of the value-added generated in the distribution sector appears in table 7.19.

As can be seen, technical change explains a high percentage of the growth rate of output compared to the other sectors. This contribution happened to be around 39 percent during the entire period. When we look to this contribution during the different subperiods we find that the highest contribution was made during the 1968-72 subperiod at 52.0 percent. The lowest contribution occured during the first subperiod.

The estimated growth rate of output tracks actual output growth fairly well in the first and last subperiod, as well as in the overall period, and almost they always rise and fall together. However, our estimate as in most of the other sector failed to capture the sharp slowdown during the second subperiod.

TABLE 7.19.

Sources of growth for the Distribution sector, 1960-1978 and subperiods.

	1960-67	1968-72	1973-78	1960-78
actual output growth rate	9.2673	2.1483	22.101	9.0149
estimated output gr-growth rate	7.6566	7.4668	19.870	9.4899
labour growth rate	3.7589	3.3024	6.3528	3.5627
capital growth rate	8.1826	3.7804	17.437	7.3353
share of labour	0.4112	0.4112	0.4112	0.4112
share of capital	0.5888	0.5888	0.5888	0.5888
weighted labour growth rate	1.5457	1.3579	2.6123	1.4650
weighted capital growth rate	4.8179	2.2259	10.267	4.3190
total factor inputs growth rate	6.3636	3.5838	12.880	5.7840
technical change growth rate	1.2930	3.8830	6.9910	3.7059
Sources of growth as a percentage of output growth				
labour	20.183	18.186	13.147	15.437
capital	62.925	29.811	51.671	45.512
total factor inputs	83.113	47.996	64.818	60.949
technical change	16.887	52.004	35.184	39.051
total	100.00	100.00	100.00	100.00

Notes: as of table 7.1.

Sources: table 6.21, H.1 and H.4.

Among the two input factors, capital and labour, capital contributed more than labour. In fact capital contributed around 45.5 percent out of 60.9 percent during the entire period. The highest contribution made by capital was during the first subperiod when it amounted to 62.9 percent, leaving only 20.2 for the labour contribution. Furthermore, labour's contribution declined with time, which is an indication that the distribution sector's technology becomes labour saving as time goes on.

Two important points are worth mentioning. Firstly, the slowdown in the value-added during the subperiod 1968-72 was as a result of the deceleration in the total factor inputs. In fact it declined by more than 50 percent of that of the first subperiod, causing a sharp decline in the value-added. And, secondly, the high contribution of capital relative to that of labour might be a result of the more sophisticated nature of some subsectors included in this sector.

Projected technical change's contribution to the growth of output in this sector shows that technical change will be a major contributor over the period 1979-90 (see table 7.20) as it has been during the previous periods.

However, our estimate shows that the growth rate of output will increase from 22.1 percent for the 1973-78 subperiod to slightly over 28.3 percent for the 1987-90 subperiod. From this high growth rate technical change will be responsible for about 41.1 percent, leaving 58.9 percent to be contributed by total factor inputs. Moreover, if we assume that capital and labour will grow by half their growth rates over the 1973-78 subperiod, technical change will contribute

TABLE 7.20.

Projected sources of growth for the Distribution sector, 1979-1990.

	1979-82	83-1986	1987-90
Growth of output	23.120	25.699	28.331
	(100.00)	(100.00)	(100.00)
Growth of technical change	8.5450	10.099	11.653
	(36.959)	(39.297)	(41.132)
Residual	14.575	15.600	16.678
	(63.041)	(60.703)	(58.868)

Sources: Tables 6.21 and H.4.

even more. This is so because output growth does not depend heavily on the growth of total factor inputs.

For Purpose of comparison table 7.21 contains data on the different contributions made to the growth of value-added in the Iraqi distribution sector as compared to that of some other countries. From the figure in this table 7.21 one can observe the following:

1 Total factor inputs is the dominant contributor to the growth of value-added. This contribution turns out to be the highest for the U.S.S.R. followed by Japan and Iraq.

2 The contribution of technical change in the Iraqi distribution sector to growth of output is at a higher level than that of the other two countries.

TABLE 7.21.
Contribution of technical change and total factor inputs to growth of output in the Distribution sector for Iraq and selected countries.

		annual % of change of			% of output explained by	
country	period	output	tfi	tc	tfi	tc
Iraq	1960-67	7.66	6.36	1.29	83.1	16.9
	1968-72	7.47	3.58	3.88	48.0	52.0
	1973-78	19.9	12.9	6.99	64.8	35.2
	1960-78	9.49	5.78	3.71	60.9	39.1
Japan*	1955-71	13.4	10.4	3.08	77.1	22.9
U.S.S.R	1961-65	5.04	3.47	1.50	68.9	31.1
	1966-70	5.82	6.18	-0.36	106.	-6.19
	1971-75	5.62	4.47	1.15	79.5	20.5
	1976-80	2.38	2.78	-0.40	116.	-6.81

Note:
* This figures coverd trade only

Sources
Figures on Japan from Nishimizu 1978.
Figures on U.S.S.R from Levine et al 1983.

7.9. SERVICES SECTOR

The contributions of technical change and of capital, labour and of total factor inputs to the growth of value-added in the services sector are presented in table 7.22.

From the estimates in table 7.22, the following notes may be extracted:

1 The contribution of technical change to growth of output during the different subperiods, as well as for the whole period, are negative. The figures show that during the entire period, as well as for the three subperiods, total factor inputs outweighed the

TABLE 7.22.

Sources of growth for the Services sector, 1960–1978 and subperiods.

	1960-67	1968-72	1973-78	1960-78
actual output growth rate	10.339	7.3601	12.729	9.6740
estimated output growth rate	10.809	6.6091	13.599	9.6985
labour growth rate	2.0751	2.4954	23.042	8.4293
capital growth rate	14.261	8.2857	10.066	10.282
share of labour	0.2776	0.2776	0.2776	0.2776
share of capital	0.7224	0.7224	0.7224	0.7224
weighted labour growth rate	0.5762	0.6927	6.3965	2.3400
weighted capital growth rate	10.302	5.9856	7.2717	7.4277
total factor inputs growth rate	10.878	6.6783	13.668	9.7677
technical change growth rate	-0.0692	-0.0692	-0.0692	-0.0692
Sources of growth as a percentage of output growth				
labour	5.3307	10.481	47.037	24.127
capital	95.309	90.566	53.472	76.586
total factor inputs	100.64	101.05	100.51	100.71
technical change	-0.6402	-1.0470	-0.5089	-0.7135
total	100.00	100.00	100.00	100.00

Notes: as of table 7.1.

Sources: table 6.24 and I.4.

decline in technical change contribution. In fact these high rates were achieved by increasing use of input factors.

2 According to our estimate it appears that the slowdown in the growth of output during the 1968-72 subperiod was caused by less investment as well as a further decline in the rate of technical change.

3 Among the inputs, capital contribution was the dominant factor. This is not likely to be the case in a sector such as the underlying sector especially in developing countries in which the labour force is the dominant input factor. This almost certainly is the result of a measurement error, most likely in the estimate of the labour force.

4 According to our estimate technology adopted in this sector is of the labour using type rather than capital intensive technology. This is clear from the declining contribution of capital and increasing contribution by labour.

Our estimate on the possible contribution to be made by technical change to output during the period 1979-90 are shown in table 7.23.

Since the specified growth rate of technical change is constant one would expect that its contribution remains the same. In fact, output growth depends on the growth of total factor inputs rather than on technological change. This is clear from the table above, if a growth rate of 13.5 percent per annum is the target, total factor inputs must increase by over 13 percent per annum. Accordingly one

TABLE 7.23.

Projected sources of growth for the Services sector, 1979-1990.

	1979-82	1983-86	1987-90
Growth of output	13.461	13.460	13.461
	(100.00)	(100.00)	(100.00)
Growth of technical change	-0.0692	-0.0692	-0.0692
	(-0.514)	(-0.514)	(-0.514)
Residual	13.530	13.529	13.530
	(100.51)	(100.51)	(100.51)

Sources: Tables 6.24 and I.4.

would expect that, assuming a decline in the growth of labour and capital growth to decline between 1983 and 1988, the result will be lower output. However, whatever assumption is made about the investment and employment magnitudes, the most striking fact in our analysis is that technical change plays a negative role and its impact is very low.

Comparison of our results with other studies is cited below in table 7.24.

From table 7.24 its clear that total factor productivity can contribute by a large percentage to the growth of value-added, even in the services sector. In fact in Taiwan total factor productivity contributed 55.3 percent to the growth of value-added during the period 1955-70 and almost half of the growth of value-added during the same period in Korea, when we look at the same figure of the

TABLE 7.24.

Contribution of technical change and total factor inputs to growth of output in the Services sector for Iraq and selected countries.

		annual % of change of			% of output explained by	
country	period	output	tfi	tc	tfi	tc
Iraq	1960-67	10.8	10.9	-0.07	100.	-0.64
	1968-72	6.61	6.68	-0.07	101.	-1.05
	1973-78	13.6	13.7	-0.07	100.	-0.51
	1960-78	9.70	9.77	-0.07	100.	-0.71
Taiwan	1960-66	11.9	3.37	8.56	28.2	71.8
	1966-70	11.1	8.04	3.06	72.4	27.6
	1955-70	9.73	4.35	5.38	44.7	55.3
Korea	1960-66	4.86	3.81	1.05	78.4	21.6
	1966-70	13.2	7.07	6.09	53.7	46.3
	1955-70	9.41	4.79	4.62	50.9	49.1
Japan	1960-66	10.5	6.58	3.92	37.3	62.7
	1966-70	12.7	5.56	7.14	43.8	56.2
	1955-70	11.0	5.87	5.13	53.4	46.6
U.S.S.R	1961-65	4.17	5.48	-1.31	131.	-31.4
	1966-70	4.18	4.95	-0.77	118.	-18.4
	1971-75	3.21	4.50	-1.29	140.	-40.2
	1976-80	2.68	4.48	-1.80	167.	-67.2

Sources:

Figures on Taiwan,Korea and Japan from Chen 1977.
Figures on U.S.S.R from Levine et al 1983.

U.S.S.R. we find it even negative during all the subperiod in table 7.24.

In Iraq total factor productivity is negative during all the subperiods as well as for the overall period. This is so because of the high growth rate of input factors, especially capital which is not accompanied by high growth of output, as can be seen in table 7.24. However for not obtaining the benefits of this huge investment there might be only one explanation; Iraq's services sector is not mature enough to gain from its high investment. It can therefore be expected that in the future, as this sector becomes more mature, total factor productivity might contribute a much large percentage.

CHAPTER EIGHT

GENERAL CONCLUSION

8.1 SUMMARY CONCLUSIONS

The main purpose of this thesis was to measure the impact of technology transfer to Iraq by measuring the changes in the technology itself and then to examine the impact of those changes on the growth of output. For this purpose the economy was disaggregated into seven sectors, over the period 1960-1978 using annual data.

We believe that the importance of this thesis lies in adding to the existing evidence on the transfer of technology experience of this country, particularly the contribution by such transfer to the process of Iraqi national development.

Since the discovery of the oil in the first half of this century, the Iraqi economy has increasingly benefitted from this natural resource, at the same time though it also poses problems for the government's economic development plans because the singular dependency has proved to be very volatile in the light of international market economic forces. Therefore, Iraqi governments have tried to put more emphasis on other areas of economic activity to diversify away from its dependency on oil as the major source of economic growth. This meant establishing a strong infrastructure to create a base for a modern technologically advanced economy; this process benefitted considerably from the oil nationalization and the world oil price rises.

In the study, growth rates of GDP were used as an indicator of economic development and in our case they compared favourably with those of other fast developing countries. Not only on an aggregate level were remarkable rates of growth achieved but also at sectoral levels.

Two distinct approaches were used for measuring technical change. The parametric approach within which two indices were constructed, i.e. Solow and Kendrick indices. While within the non-parametric approach three specifications were given to technological change: constant, variable and continous, and variable and discrete. Statistical tests were used for selecting the form which best fitted within the last approach. Then the prefered equations were used for isolating the various sources of growth with technical change being one of them. Next, attempts were made to simulate the output levels. By doing so we were able to find how well our equations succeeded in approximating the actual figures. Finally we projected the output levels up to 1990 and estimated the contribution that could be made to output. This was done for both the entire economy and each of its seven sectors.

The results obtained depend in their accuracy on the correct specifications of the production function and technical change.

Another vital factor for the accuracy of the estimated figures is that they are dependant on the quality of the data, in other words, how well the series of capital and labour reflect changes in the productivity of those variables. In addition another factor affected the quality of the estimate, namely the problem of collinearity between labour, capital, and the time trend. This resulted in difficulties when separating the effects of each of those factors on output.

According to our study, the technological change that occured during the period under consideration was growing in variable and continous rates in the economy, manufacturing, construction, and distribution sectors. While in the agricultural, electricity,gas and water, services, and mining and quarrying sectors, they were growing at constant rates. Furthermore in the agricultural and services sectors technological change was growing at a declining rate.

For the economy as a whole the chief findings of this study are: the best functional form describing the production process on an aggregate level is the one with unitary elasticity of substitution and variable and continuous specification of technical change; Iraq in its development depends on the intensive use of factor inputs, especially capital. However, this is acceptable only during the first stages of development and it is expected that technical change will be a potential factor for economic growth; since capital, the faster growing input, is associated with a relatively high share in output, the contribution from total factor inputs to growth of output will keep on increasing as long as capital increases at a higher rate than that of labour. And finally the most important factor in economic growth is capital, whilst labour is of very little importance. This is either caused by data inaccuracy or because of the overuse of labour as a consequence of the full-employment policy.

With regard to the agricultural sector the major conclusions according to our results are: the C-D functional form with constant technical change specification is the one underlying the production process in this sector; this sector is unable to gain as much as other sectors do from the transfer of technology; technical change and labour input are less important contributors to the growth of output and finally, since capital contribution is increasing over time, one can conclude that technical change in this sector is of capital usage nature. This result is appreciable since it leads to further release of labour from this sector for employment in more modern sectors.

The principal findings of the analysis of the manufacturing sector are: the best form among the different forms used in this analysis describing the manufacturing production process is a Cobb-Douglas function with a variable and continuous growth rate of technical change; production technology changed at an increasing rate and contributed about one fifth of the growth rate of the output generated in this sector over the period studied. However, this contribution during the earlier periods, as in most of the other sectors, was lower and even negative during the 1960s which might be attributed to the non-availability of a skilled labour force to absorb this technology in the right manner. Despite this the increasing contribution of technological change in this sector and the other sectors during the 1970s can be attributed to the successful assimilation of the highly advanced technology transferred from the developed world.

As that of the economy, the elasticity of output with respect to capital is high relative to that of labour. Again in an economy with an abundance of capital and scarcity of skilled labour, like most of the developing countries, this would be desirable.

The implication of our findings is that, as long as output elasticity with respect to capital (the faster growing input) is high, and technical change is growing at a variable rate, output will continue to grow at even higher rates. Moreover, technical change will play a more important role in the long-run development of this sector.

The mining and quarrying sector is also characterized by a unitary elasticity of substitution production function with a constant rate of technical change specification. The observed rate of technical change was very low as measured by both direct and indirect estimates. This resulted from the fact that the oil industry which constitutes the major part of this sector is a demand side, rather than a supply side industry and thus outputs are determined by forces other than the production factors. Unusual though, is the fact that labour input is the most important input factor here. In a sector well described as a capital intensive sector this should not be the case, however, as we have mentioned in chapter six the data is the factor to blame for such discrepancies.

It was concluded that the C-D with constant rate of technical change specification is the best functional form to fit the data of the electricity, gas and water sector; capital is the major contributor for the output and the change in the technology itself is not of great significance.

The construction and distribution sectors, according to our empirical findings, show that they were enjoying rapid and high rates of growth of technical change and it is thought likely that they will keep growing at increasing rates. Labour's contribution to the growth of output in the construction sector was higher than that of capital and there has been evidence of a biased technical change of the labour usage type since 1973 in this sector. Unlike the construction sector, capital has made the largest contribution in the distribution sector. Furthermore, labour's contribution declined with time, which is an indication that the distribution sector's technology becomes labour saving as the time goes on.

The conclusion that can be made based on the findings of our study on the impact of technical change, the agent of technology transfer, on the growth of output generated in the services sector is that this sector has not gained from the technology transfer. In fact output growth depended on the extensive use of input factors especially labour. Technical change according to our study is of a labour usage nature. Thus it seems that the majority of the labour force that was released from the agricultural sector found jobs in the services sector, and as a result it is predictable that this sector will continue to absorb labour.

In conclusion then, the empirical findings of this study show that Iraq, as far as aggregate and sectoral levels are concerned, was not gaining much from the technology transfer to it, at least up to 1973. Moreover, some sectors were unable to generate high rates of technological change even during the period 1973-1978. However, in some sectors such as manufacturing, construction, and distribution, as well as in the economy as a whole, technical change seems to have been of a great importance, viz the growth of output.

It should be noted that regardless of the gain from the transferred technology, the domestic production of technology should be the final orientation of the transferor. The normal start for doing so is the decision not to re-import the technology, i.e. it should be fully understood through undertaking the nessesary research and development in order to copy this imported technology, therefore enhancing domestic technology and reducing the need for imported technology. This reduces the dependancy on foreign developed technology.

8.2 POLICY IMPLICATIONS

In spite of the problems inherent in our estimates and the crude nature of the data utilized by this study, our conclusions have some policy implications which might help the policy makers in the allocation of the available resources among different sectors.

It is clear from the analysis in chapter seven that maximizing output in the whole economy, manufacturing, electricity, gas and water, distribution, and services sectors can be reached by devoting more capital to those sectors since the output elasticity with respect to capital is higher than that of labour. While agricultural, mining and quarrying, and construction sectors can maximise output by employing more labour rather than increasing capital usage.

This hypotheses is based on the fact that demand should not be an obstacle for maximizing output which is unlikely, since in a developing country, sufficient demand is always present.

8.3 SUGGESTIONS AND RECOMMENDATIONS FOR FURTHER WORK

This work prompts several suggestions for further research in this area.

First, It would be of interest to classify the technology transferred according to their origin, and then find the impact individually on the growth of output. However, this is conditional on the availability of the required data.

Second, one direction in this area could be orientated towards explaninig technical change rather than measuring it as in this study, whether these sources are economies of scale or growth of factor inputs, the carrier of technical progress. The bulk of this kind of study has been well established for the developed countries. This application would be useful to find the sources of technical change on aggregate and sectoral levels.

Third, the work carried out in this study restricted the elasticity of substitution between the input factors to a certain value and assumed this value to be constant over the period studied. In fact over a long period of time one would expect sizable movement for substitution between the input factors. It would be of considerable practical importance if this restriction could be removed and then testd in conjunction with the findings of this study.

Fourth, since studies regarding production are very sensitive to the data utilized, further work might be carried out using different sets of data, such as number of hours worked rather than number of persons employed or using electricity consumption instead of capital stock. Many other studies in this area found that such data is more able to reflect the services of the input factors than is the data used in this study. Again this is conditional on the data availability.

Fifth, using a totally different approach from the one adopted in this study and then making a comparison with the findings of this study might be of great interest. Such a study might make use of the Verdoorn law or the input/output analysis

Sixth, another practical application recommended is to measure technical change on further disaggregation levels for the different sectors, especially in the manufacturing sector. This would be more fruitful than studies on aggregate levels. Findings of such studies can then be compared with international data and by doing so, the performance of the input factors as well as of technical change would be revealed.

Finally, this work could be extended to include raw materials as another factor in the production function along with capital and labour. Indeed some other studies show that in this case intermediate input saving is better segmented, thus making it easier to identify transferred technology, due to its direct impact.

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APPENDIX A

TABLE A.1

Distribution of GDP by Economic Sector, 1960-1978

(In Million Dinar at Current Prices)

Sectors	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
Agricultural	97.800	117.00	140.40	109.300	133.30	153.20	163.40	187.80	196.00	191.00	206.90
Manufacturing	54.400	59.510	65.200	64.200	63.700	69.400	74.700	83.400	94.600	103.00	116.00
Mining and Quarrying	209.80	211.20	212.10	244.40	275.10	285.90	304.20	270.60	341.00	343.20	370.50
Eectricity, Gas, and Water	3.6200	4.9600	5.5400	5.2000	11.100	12.000	12.600	12.800	14.900	16.800	17.800
Construction	23.080	23.880	19.640	20.300	26.700	30.500	34.500	32.800	36.800	38.500	40.600
Distribution	80.960	93.590	96.960	97.500	115.60	137.50	150.30	156.00	165.80	174.70	188.40
Services	95.710	105.00	118.70	129.70	168.20	179.10	198.30	198.50	217.90	242.50	262.20
Total	565.40	615.10	658.40	670.60	793.70	867.60	938.00	941.90	1067.0	1109.7	1202.4

(Table Continued in next page)

Table A.1 Continued

Sectors	1971	1972	1973	1974	1975	1976	1977	1978
Agricultural	212.50	269.40	225.90	232.10	281.50	391.30	498.40	550.50
Manufacturing	118.50	140.00	157.60	176.10	270.60	379.80	488.60	506.20
Mining and Quarrying	512.90	407.30	574.30	2030.7	2061.5	2819.2	3114.9	3729.6
Electricity Gas, and Water	11.900	13.700	16.000	13.700	17.200	22.500	27.400	42.900
Construction	43.600	45.200	57.600	69.100	356.10	441.90	415.90	559.30
Distribution	194.70	208.50	224.20	337.20	482.40	590.40	690.20	902.10
Services	280.90	304.70	331.90	488.80	565.50	606.90	773.10	934.80
Total	1375.0	1388.8	1587.5	3347.7	4034.8	5252.0	6008.5	7225.4

Sources:

Figures for the years 1960-1963 from Ministry of Planning, "*Annual Abstract of Statistics, 1970*", Table 191, pp 336-337;For the years 1971-1974 from Ministry of Planning, " *Annual Abstract of Statistics, 1976*", Table 6/4, p 178; for on Manufacturing, Construction, Electricity, Gas & Water, and Agriculture sectors are from Abdul-Amir, J., "*National Account and Capital Formation*", Ministry of Planning, 1979, and for the years 1977-1978 from Ministry of Planning, "*Annual Abstract of Statistics, 1982*", Table 5/4, p 116. While those on Distribution and Services sectors for the years 1975-1978 from Ministry of Planning,"*Annual Abstract of Statistics, 1981*", Table 5/2, p 120.

TABLE A.2

Implicit Price Deflator for GDP by Economic Sectors at 1969 Constant Prices.

Sectors	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
Agricultural	90.293	88.113	89.340	92.359	94.340	90.755	94.340	100.08	98.028	100.00	108.72
Manufacturing	90.392	88.111	88.254	92.357	94.309	90.755	94.341	102.49	98.907	100.00	98.390
Mining and Quarrying	90.343	88.080	89.306	92.324	94.304	90.771	94.304	102.41	98.548	100.00	115.82
Eectricity, Gas, and Water	90.332	88.106	89.323	92.369	94.322	90.721	94.322	94.746	98.566	100.00	100.00
Construction	90.378	88.105	89.331	92.331	94.331	90.709	94.331	102.42	98.557	100.00	104.37
Distribution	90.377	88.113	89.340	92.359	94.340	90.774	94.340	94.660	98.585	100.00	101.35
Services	90.377	88.123	89.340	92.359	94.340	90.745	94.340	102.45	98.585	100.00	103.63

(Table Continued in next page)

Table A.2 Continued

Sectors	1971	1972	1973	1974	1975	1976	1977	1978
Agricultural	118.25	117.85	125.15	139.82	181.83	233.19	250.67	269.67
Manufacturing	97.730	105.58	109.83	114.57	130.76	137.04	133.64	142.66
Mining and Quarrying	156.04	122.31	125.45	459.84	443.87	404.89	448.12	450.69
Electricity Gas, and Water	100.00	100.00	100.00	73.660	75.640	88.690	98.850	103.40
Construction	109.00	106.86	112.72	142.11	197.97	240.17	232.66	229.62
Distribution	102.17	102.66	102.69	114.64	136.34	146.91	159.52	165.84
Services	107.27	113.62	119.32	125.92	120.74	131.24	139.93	145.36

Sources:

Figures for the years 1960-1969 from Hashim, J., Omar, H., and Al-monoufy, A., " *Evaluation of Economic Growth in Iraq, 1950-1970*", Vol. 1, Ministry of Planning, Baghdad, Iraq, 1970. Table 18, p 171; for the years 1971-1974 from, Ministry of Planning, ."*Annual Abstract of Statistics, 1976*", Tables 6/4 and 6/5 pp 178-179. And for the years 1975-1978 are taken from IMF, "*International Financial Statistics*", Yearbook : 1984, Washingron D.C, pp 90-91

TABLE A.3

Distribution of Capital Formation by Economic Sector, 1960-1978
(In Million Dinar at Current Prices)

Sectors	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
Agricultural	12.00	14.90	11.20	8.700	9.900	11.50	15.80	15.00	16.70	22.50	23.00
Manufacturing	9.000	12.80	20.90	21.10	22.40	25.40	30.60	34.30	36.40	40.10	42.50
Mining and Quarrying	23.10	22.80	5.000	1.700	0.900	1.100	1.500	1.500	1.200	1.100	7.600
Eectricity, Gas, and Water	7.800	5.000	4.900	7.300	11.60	10.70	11.50	12.50	8.600	8.500	12.10
Construction	1.300	1.900	1.700	1.100	1.300	1.900	2.400	2.500	1.700	4.000	3.900
Distribution	28.10	36.00	33.10	30.70	31.10	29.60	36.50	30.40	29.10	24.90	36.20
Services	38.20	43.80	42.60	36.60	44.80	49.70	51.30	46.70	49.20	56.10	59.90
Total	119.5	137.2	119.4	107.2	121.7	129.9	149.6	142.9	142.9	157.2	185.2

(Table Continued in next page)

Table A.3 Continued

Sectors	1971	1972	1973	1974	1975	1976	1977	1978
Agricultural	29.00	31.30	33.90	47.80	81.50	131.2	147.6	166.6
Manufacturing	43.40	50.30	69.10	123.7	242.0	248.4	336.0	259.8
Mining and Quarrying	10.40	13.20	30.70	79.60	87.10	156.8	90.80	196.6
Electricity Gas, and Water	11.00	10.70	9.800	7.300	70.00	77.70	48.40	165.8
Construction	5.100	5.000	7.800	21.30	35.90	49.70	38.30	47.30
Distribution	36.50	39.30	61.20	111.1	358.9	455.1	315.8	401.4
Services	59.30	67.20	76.10	141.1	192.3	217.6	321.7	543.3
Total	189.7	217.0	273.7	531.9	1067.7	1336.5	1298.6	1780.8

Sources:

Figures for the years 1960-1970 from Ministry of Planning, "*Annual Abstract of Statistics, 1971*", Table 326, pp 461; for the years 1971-1972from Ministry of of Planning, " *Annual Abstract of Statistics, 1974*", Table 204, p 285; for the years, 1973-1974 from,"*Annual Abstract of Statistics, 1976*", Table 6/12, p 185, and for the years 1975-1978 from *Abdul-Amir, J.*, "*National Account and Capital Formation*", Ministry of Planning, 1979, pp 30-32.

TABLE A.4

Implicit Price Deflator for Capital Formation by Economic Sectors at 1969 Constant Prices.
(In Million Dinar)

Sectors	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
Agricultural	87.585	90.385	89.775	95.251	92.585	92.181	93.940	95.843	97.989	100.00	102.73
Manufacturing	86.397	87.903	89.278	90.135	91. 733	91.808	93.554	96.902	98.777	100.00	102.54
Mining and Quarrying	93.334	91.709	90.909	90.909	90.909	90.909	97.400	104.89	99.173	100.00	104.68
Eectricity, Gas, and Water	91.765	89.414	89.413	89.413	92.606	91.989	93.482	95.529	97.336	100.00	102.07
Construction	81.250	87.497	87.497	87.497	87.497	92.362	95.450	99.431	99.160	100.00	100.37
Distribution	90.121	98.158	89.158	88.294	94.312	94.927	102.34	102.28	100.56	100.00	104.79
Services	93.809	91.839	90.375	89.155	92.653	91.667	93.855	96.141	98.590	100.00	103.12

(Table Continued in next page)

Table A.4 Continued

Sectors	1971	1972	1973	1974	1975	1976	1977	1978
Agricultural	103.73	105.64	108.18	146.75	191.64	215.71	231.97	242.75
Manufacturing	112.63	105.66	108.67	144.83	190.31	211.25	226.11	239.02
Mining and Quarrying	105.05	107.15	108.32	147.16	191.49	219.38	232.99	241.59
Electricity Gas, and Water	103.53	105.13	107.61	144.90	190.17	212.66	227.27	239.61
Construction	103.77	104.16	114.66	141.28	182.28	195.27	209.65	223.38
Distribution	104.64	106.83	108.02	146.27	188.81	214.27	229.20	239.74
Services	104.27	105.99	105.44	140.96	176.48	197.79	219.00	220.48

Sources:

Figures for the years 1960-1970 from Ministry of Planning, ."*Annual Abstract of Statistics, 1971*", Table 327, p 459; for the years 1971-1972 from Ministry of Planning, "*Annual Abstract of Statistics, 1974*", Table 205, p 286; figures on the years 1973-1974 are from Ministry of Planning, "*Annual Abstract of Statistics, 1976*", Table, 6/13, p 186. And for the years 1975-1978 from Abdul-Amir, J. "*National Account and Capital Formation*", Ministry of Planning, 1979.

TABLE A.5

Distribution of Capital Formation by Economic Sector, 1960–1978
(In Million Dinar at Constant Prices, 1969-100)

Sectors	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
Agricultural	13.70	16.49	12.48	9.134	10.69	12.48	16.82	16.49	17.04	22.50	22.39
Manufacturing	10.42	14.56	23.41	23.41	24.42	27.67	32.71	35.40	36.85	40.10	41.45
Mining and Quarrying	24.75	24.86	5.500	1.870	0.990	1.210	1.540	1.430	1.210	1.100	7.260
Eectricity, Gas, and Water	8.500	5.592	5.480	8.164	12.53	11.63	12.30	13.09	8.835	8.500	11.86
Construction	1.600	2.172	1.943	1.257	1.486	2.057	2.514	2.514	1.714	4.000	3.886
Distribution	31.18	36.68	37.13	34.77	32.98	31.18	35.67	29.72	28.94	24.90	34.55
Services	40.72	47.69	47.14	41.05	48.35	54.22	54.66	48.57	49.90	56.10	58.09
Total	130.9	148.0	133.1	119.7	131.4	140.4	156.2	147.2	144.5	157.2	179.5

(Table Continued in next page)

Table A.5 Continued

Sectors	1971	1972	1973	1974	1975	1976	1977	1978
Agricultural	27.96	29.63	31.34	32.57	42.53	60.82	63.63	68.63
Manufacturing	38.53	47.61	63.59	85.41	127.2	117.6	148.6	108.7
Mining and Quarrying	9.900	12.32	28.34	54.09	45.49	71.48	38.97	81.38
Electricity Gas, and Water	10.63	10.18	9.107	5.038	36.81	36.64	21.30	69.20
Construction	4.915	4.800	6.803	15.08	19.70	25.45	18.27	21.18
Distribution	34.88	36.79	56.66	75.96	190.1	212.4	137.8	167.4
Services	56.87	63.40	72.17	100.1	109.0	110.0	147.9	246.4
Total	183.7	204.7	268.0	368.2	570.8	634.4	575.5	762.9

Data Source: Compiled from data in tables A.3 and A.4.

TABLE A.6
Distribution of Expenditure on R & D in 1974
(Iraqi Dinars)

Purpose	Amount Allocated	%
Explorations and assesment of earth, the sea, atmosphere and space	86,112	1.2
Development of agricultural, forestry and fishing	3,437,853	46.6
Promotion of industrial development	635,092	8.6
Production, conservation and distribution of energy	197,540	2.7
Development of transport and communication	-	-
Development of education services	-	-
Development of health services	45,000	0.6
Social development and other socio-economic services	381,708	5.2
Protection of environment	-	-
General advancement of knowledge	2,493,439	33.8
Other aims	95,823	1.3
Total	7,372,567	100.0

Source: Pfetsch, Frank R., "*Iraq, Science, Technology and Development*", UNESCO, 1975.

Table A.7

Correlation Coefficients between the Indepedent Variables for the Economy and its Sectors

Economy/Sector	r_{kl}	r_{kt}	r_{lt}
Economy	0.94347	0.94886	0.99847
Agriculture	0.26551	0.96320	0.50211
Manufacturing	0.97068	0.94135	0.92203
Mining and Quarrying	0.87201	0.84162	0.91794
Electricity, Gas and Water	0.84874	0.99033	0.89312
Construction	0.98315	0.85795	0.83867
Distribution	0.96931	0.89563	0.97318
Services	0.89139	0.98473	0.81664

Table A.8

Regression Results of the CES Production Function
for the Economy and its Sectors

Economy/ Sector	LnA	$\delta \text{Ln}\left[\frac{K}{L}\right]$	ρ	Lag parameter	Dummy parameter	R^2 [a]	D.W.[b]	SSR[c]
Economy	0.001965	0.564103	−0.134395	0.212341		0.949	1.6266	0.050230
	0.020461[d]	0.167791	0.152457	0.152321				
	(0.096047)[e]	(3.36194)	(−0.881527)	(1.39994)				
Agriculture	0.043590	0.014642	−0.014520		−0.256797	0.676	1.7716	0.151779
	0.037749	0.459421	0.220838		0.121963			
	(1.15476)	(0.031874)	(−0.065749)		(−2.10553)			
Manufacturing	0.019693	0.894673	−0.083651	0.345060		0.959	1.6963	0.079866
	0.025645	0.303536	0.116021	0.108176				
	(0.767882)	(2.94750)	(−0.720997)	(3.18981)				
Mining and Quarrying	0.689215	0.234448	0.360196	−0.169212	0.135604	0.962	1.9406	0.948399
	0.468186	0.579738	3.285323	0.105375	0.074870			
	(1.47216)	(0.404403)	(0.109638)	(−1.6106)	(1.811190)			
Electricity, Gas and Water	−0.105186	0.052871	0.023922			0.853	1.3970	0.481137
	0.046359	0.0292110	0.067190					
	(−2.26894)	(0.180996)	(0.356035)					
Construction	−0.298015	0.49544	−0.261877	0.437913		0.821	2.4820	0.433206
	0.063322	0.497544	0.422173	0.187636				
	(−0.47056)	(2.37300)	(0.620307)	(2.33387)				
Distribution	0.029410	1.40471	0.721480			0.903	1.2894	0.182429
	0.029925	0.157075	0.785178					
	(−0.98279)	(8.94296)	(0.918875)					
Services	0.005124	0.689155	0.713914			0.983	2.2197	0.082970
	0.023094	0.117211	0.835702					
	(0.221858)	(5.87958)	(0.854269)					

Notes: [a] coefficient of determination [b] Durbin Watson Statistic [c] Sum Square Residual
[d] Standard Error of the Corresponding Parameter [e] *t* value of the parameter

Table A.9

Regression Results of the Cobb-Douglas Production Function
for the Different Sectors

Economy/ Sector	Ln A	δLn K	(1-δ)Ln L	Lag parameter	Dummy parameter	R^2 [a]	D.W.[b]	SSR[c]	Method
Economy	-0.61225	0.39533	0.60467		0.28547	0.976	1.5643	0.081457	OLS
	0.058674[d]	0.088203			0.05867				
	(-17.90)[e]	(4.4821)	(0.85560)						
Agriculture	-1.3920	0.30011	0.69989			0.585	1.9130	0.27336	Auto
	0.22050	0.13901							
	(-6.312)	(2.1588)	(5.0347)						
Manufacturing	0.05228	0.66709	0.33291		0.23365	0.979	1.6171	0.11373	Auto
	0.045202	0.10875			0.08210				
	(1.2218)	(0.1340)	(3.0612)		(2.8459)				
Mining and Quarrying	-0.057818	0.31447	0.68553			0.950	2.0875	0.11693	Auto
	0.024424	0.20531							
	(-2.3947)	(1.5315)	(3.339)						
Electricity, Gas and Water	-1.73020	0.83262	0.16738			0.875	1.7511	0.59932	Auto
	0.40457	0.19348							
	(-4.2760)	(4.3033)	(0.8651)						
Construction	-0.042973	0.65647	0.34353		0.41782	0.954	1.6256	0.41805	Auto
	0.23804	0.12395			0.11086				
	(0.33564)	(5.2961)	(2.7715)		(3.7679)				
Distribution	-2.3242	0.59128	0.40872	0.35201		0.954	1.0699	0.17693	Auto
	0.96006	0.58564		0.26640					
	(-2.4209)	(1.0096)	(0.69791)	(1.3214)					
Services	-0.75424	0.72537	0.27463			0.981	2.0489	0.080967	Auto
	0.03051	0.05225							
	(-24.724)	(13.883)	(5.2561)						

Notes: a coefficient of determination b Durbin Watson Statistic c Sum Square Residual
d Standard Error of the Corresponding Parameter e *t* value of the parameter

APPENDIX B

TABLE B.1.

Production function data for the Whole Economy, 1960-1978

Year (1)	Q output (million 1969 I.D) (2)	L labour (thousand employed) (3)	K capital stock (million 1969 I.D) (4)
1960	625.740	1599.70	829.030
1961	698.120	1670.00	946.880
1962	737.970	1728.00	1078.50
1963	726.190	1787.10	1193.10
1964	841.460	1852.30	1293.00
1965	956.100	1985.30	1403.20
1966	994.410	2107.00	1521.00
1967	937.340	2200.60	1653.10
1968	1083.30	2323.40	1774.20
1969	1109.70	2402.80	1890.90
1970	1123.70	2506.70	2018.60
1971	1191.90	2592.60	2166.70
1972	1230.50	2676.00	2317.80
1973	1360.00	2761.00	2485.80
1974	1499.10	2643.80	2715.60
1975	1912.20	2941.80	3042.10
1976	2190.10	2962.20	3566.00
1977	2451.20	3032.20	4143.60
1978	2858.60	3158.70	4651.50

Sources:

1. Output figures are from table A.1 and deflated by their implict price deflator stated in table A.2.
2. Capital stock figures are calculated from the figures in table A.5
3. figures on number of persone employed for the years 1960-70 are from Statistical pocketbook (1972), table 10, p 27, Ministry of planning; For the years 1970-1973 are taken from Annual Abstract of Statistics 1973, table 208, p 358; for the years 1974-75, long-run planning committee, table 5, p 599-601, Ministry of planning; And for the years 1976-1978 from, Manpower planning committee, tasks number (6-1), vol 1, table 2-4, p 39-40, Ministry of planning.

TABLE B.2.

Capital productivity, labour productivity and capital /labour ratio for the Whole Economy.

year	capital productivity Q/K	labour productivity Q/L	capital/labour ratio K/L
1960	0.75479	0.39116	0.51824
1961	0.73728	0.41803	0.56699
1962	0.68426	0.42706	0.62413
1963	0.60866	0.40635	0.66761
1964	0.65078	0.45427	0.69805
1965	0.68137	0.48159	0.70679
1966	0.65378	0.47195	0.72187
1967	0.56702	0.42594	0.75120
1968	0.61058	0.46625	0.76362
1969	0.58686	0.46183	0.78695
1970	0.55667	0.44827	0.80528
1971	0.55010	0.45973	0.83572
1972	0.53089	0.45982	0.86614
1973	0.54710	0.49257	0.90032
1974	0.55203	0.56702	1.02710
1975	0.62858	0.65001	1.03410
1976	0.61416	0.73934	1.20380
1977	0.59156	0.80839	1.36650
1978	0.61455	0.90499	1.47260

Data source: Compiled from data in table B.1.

TABLE B.3.

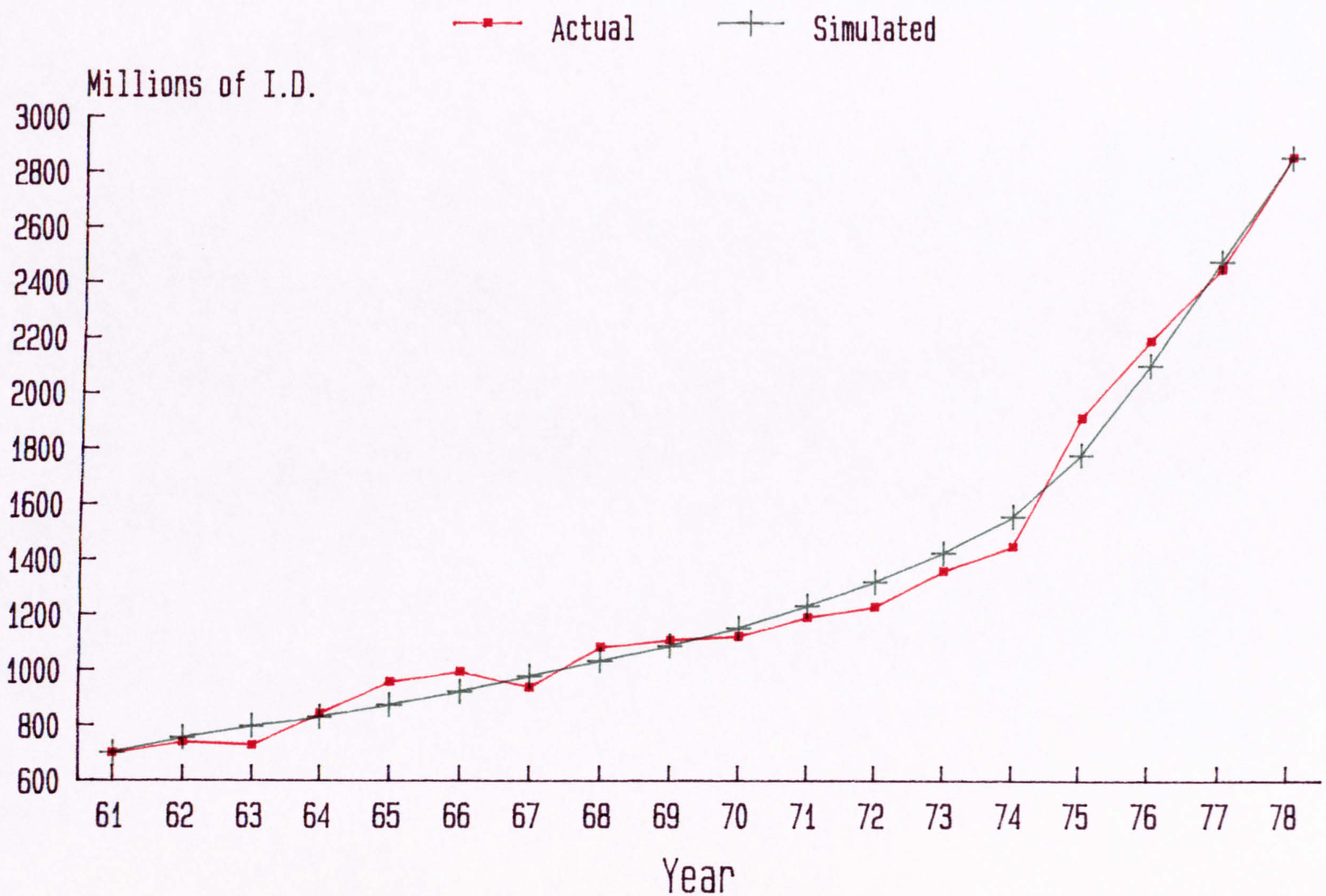
Actual and simulated levels of output for the Whole Economy, 1961-1978.

YEAR (1)	actual output (million 1969 I.D) (2)	simulated output (million 1969 I.D) (3)
1961	698.120	697.687
1962	737.970	752.217
1963	726.190	794.288
1964	841.460	827.933
1965	956.100	871.789
1966	994.410	920.470
1967	937.340	977.110
1968	1083.30	1032.19
1969	1109.70	1086.36
1970	1123.70	1151.89
1971	1191.90	1232.05
1972	1230.50	1320.04
1973	1360.00	1424.44
1974	1499.10	1556.13
1975	1912.20	1778.09
1976	2190.10	2099.93
1977	2451.20	2477.92
1978	2858.60	2856.37

Sources:

1. The actual levels of output of column (2) are frome table B.1 column (2).
2. The simulated levels of output are derived by using equation in table 7.3 and series of labour and capital stated in table B.1.

Figure B.1 Actual and Simulated Levels of Output for The Whole, Economy, 1961-1978



Source: Table B.3

TABLE B.4.

Capital stock and labour force data for the Whole Econony used for prediction and predicted output levels, 1979-1990.

YEAR (1)	labour force (thousnd employed) (2)	capital stock (million 1969 I.D) (3)	predicted output (million 1969 I.D) (4)
1979	3258.80	5298.10	3347.32
1980	3362.10	6034.50	3942.40
1981	3468.70	6873.30	4666.25
1982	3578.70	7828.70	5550.30
1983	3692.10	8916.90	6634.46
1984	3809.10	10156.3	7969.53
1985	3929.80	11568.0	9620.60
1986	4054.40	13176.0	11671.2
1987	4182.90	15007.5	14228.8
1988	4315.50	17093.5	17432.6
1989	4452.30	19469.5	21463.3
1990	4593.40	22175.8	26556.6

Notes:

1. Figures of capital stock in column (2) are derived by assuming growth rate of 13.9 Percent.

2. Figures of labour force in column (3) Are derived by assuming growth rate of 3.17 percent.

3. Predicted levels of output are derived by using equation in table 6.3.

TABLE B.5.

Results of ordinary least squares estimation of the Whole Economy growth rates.

	ln α	ln β	R^2	SSR*	rate of growth
GDP					
1960–1967	6.3945 (142.9)**	0.0657 (7.415)	0.90	0.0198	6.7944
1968–1972	6.6856 (141.5)	0.0326 (7.655)	0.95	0.0198	3.3165
1973–1978	5.0793 (35.46)	0.1522 (17.62)	0.99	0.0052	16.433
1960–1978	6.3202 (117.3)	0.0747 (15.81)	0.94	0.2164	7.7595
Capital stock					
1960–1967	6.9994 (301.1)	0.0962 (21.91)	0.99	0.0048	10.085
1968–1972	6.8753 (832.2)	0.0671 (90.03)	0.99	0.0000	6.9369
1973–1978	5.9670 (63.52)	0.1303 (23.01)	0.99	0.0022	13.914
1960–1978	6.6915 (245.6)	0.0864 (36.16)	0.99	0.0553	9.0246
Labour force					
1960–1967	7.3200 (633.3)	0.0458 (20.01)	0.99	0.0013	4.6861
1968–1972	7.4284 (659.0)	0.0359 (35.28)	0.99	0.0000	3.6512
1973–1978	7.4622 (60.95)	0.0312 (4.223)	0.82	0.0038	3.1661
1960–1978	7.3626 (465.4)	0.0384 (27.67)	0.98	0.0187	3.9127

(Continued)

Table B.5 Continued

	ln α	ln β	R^2	SSR	rate of growth
Total factor Inputs					
1960-1967	4.5462 (880.8)	0.0681 (66.65)	0.99	0.0003	7.0493
1968-1972	4.6839 (887.7)	0.0517 (108.6)	0.99	0.0000	5.3019
1973-1978	4.1167 (45.51)	0.0900 (16.50)	0.99	0.0021	9.4136
1960-1978	4.5603 (295.5)	0.0639 (46.84)	0.99	0.0177	6.5445
Kendrick's Index					
1960-1967	4.6198 (104.2)	-0.0024 (-0.28)ns	0.01	0.0194	-0.2410
1968-1972	4.7731 (102.4)	-0.0190 (-4.53)	0.87	0.0005	-1.8853
1973-1978	3.7340 (25.70)	0.0623 (7.099)	0.93	0.0054	6.4153
1960-1978	4.5314 (102.3)	0.0113 (2.916)	0.33	0.1463	1.1396
Solow's index					
1960-1967	4.6177 (98.62)	-0.0005 (-0.06)ns	0.00	0.0217	-0.0520
1968-1972	4.7649 (92.69)	-0.0165 (-3.56)	0.81	0.0006	-1.6369
1973-1978	3.4263 (27.20)	0.0816 (11.35)	0.97	0.0040	8.9980
1960-1978	4.5009 (81.98)	0.0179 (3.727)	0.45	0.2247	1.8108
1960-1967	-0.2719 (-5.59)	-0.0303 (-3.15)	0.62	0.0234	-2.9889

(continued)

Table B.5 continued

	LN α	LN β	R^2	SSR	rate of growth
1968-1972	-0.1897 (	-0.0344 (	0.97	0.0113	-3.3855
1973-1978	-0.8877 (-4.71)	0.0219 (1.925)	0.48	0.0090	2.2113
1960-1978	-0.3712 (-9.83)	-0.0117 (-3.53)	0.42	0.1062	-1.1604
Labour Productivity					
1960-1967	-0.9255 (-20.4)	0.0199 (2.217)	0.45	0.0204	2.0140
1968-1972	-0.7428 (-13.5)	-0.0032 (-0.65)ns	0.12	0.0007	-0.3228
1973-1978	-2.3829 (-30.9)	0.1210 (26.00)	0.99	0.0015	12.860
1960-1978	-1.0424 (-16.4)	0.0363 (6.525)	0.71	0.3007	3.7019
Capital/labour ratio					
1960-1967	-0.6536 (-20.5)	0.0503 (7.944)	0.91	0.0101	5.1570
1968-1972	-0.5531 (-33.0)	0.0312 (20.69)	0.99	0.0001	3.1700
1973-1978	-1.4952 (-10.9)	0.9910 (11.63)	0.97	0.0051	10.418
1960-1978	-0.6711 (-18.8)	0.0480 (15.37)	0.93	0.0946	4.9194

Notes:
* stand for the sum squared of residual
** stand for t values
ns stand for not significant
Equation used as the following:
$\ln y = \ln \alpha + t \ln \beta + \epsilon$
Where
y = The dependent variable
t = Time
the growth rate = exp (β) - 1

Sources: Calculated from data in tables B.1,B.2,6.1 and 6.2.

APPENDIX C

TABLE C.1.

Production function data for the Agricultural sector, 1960-1978.

Year (1)	Q Output (Million 1069 I.D) (2)	L Labour (Thousnd Employed) (3)	K Capital Stock (Million 1969 I.D) (4)
1960	108.360	733.900	130.730
1961	132.760	780.500	140.510
1962	157.130	827.000	152.780
1963	118.340	873.500	160.670
1964	141.300	920.100	164.980
1965	168.810	1009.60	170.730
1966	173.200	1103.10	178.080
1967	187.660	1177.40	189.560
1968	199.940	1253.60	200.350
1969	191.000	1306.40	211.390
1970	190.310	1385.70	227.540
1971	179.700	1434.70	248.110
1972	228.600	1469.10	264.770
1973	180.500	1398.40	285.490
1974	166.000	1325.60	308.260
1975	154.810	1215.40	331.590
1976	167.800	1041.20	364.170
1977	198.880	941.700	414.070
1978	204.140	941.700	465.270

Sources:

1. Output figures are from table A.1 and deflated by their implict price deflator stated in table A.2.
2. Capital stock figures are calculated from the figures in table A.5
3. Figures on labour force in column (3) for the period 1960-1970 are taken from statistical pocketbook (1972), table 10, p 27, Ministry of planning; For the years 1971-1973 are taken from Annual Abstract of Statistics 1973, table 208, p 358, Ministry of planning; And for the remaaning years are from Samarra (1981), table 9.4.1, p 436.

TABLE C.2.

Capital productivity, labour productivity, and capital labour ratio for the Agricultural sector, 1960-1978.

Year	Capital Productivity Q/K	Labour Productivity Q/L	Capital/Labour Ratio K/L
1960	0.82888	0.14765	0.17813
1961	0.94484	0.17009	0.18002
1962	1.02840	0.19000	0.18474
1963	0.73654	0.13547	0.18393
1964	0.85646	0.15357	0.17931
1965	0.98875	0.16720	0.16911
1966	0.97259	0.15701	0.16143
1967	0.98997	0.15938	0.16100
1968	0.99795	0.15949	0.15982
1969	0.90354	0.14620	0.16181
1970	0.83638	0.13733	0.16420
1971	0.72427	0.12525	0.17293
1972	0.86339	0.15560	0.18022
1973	0.63224	0.12907	0.20415
1974	0.53850	0.12522	0.23254
1975	0.46687	0.12737	0.27282
1976	0.46077	0.16116	0.34976
1977	0.48030	0.21119	0.43970
1978	0.43875	0.21677	0.49407

Data Source: Compiled from table C.1.

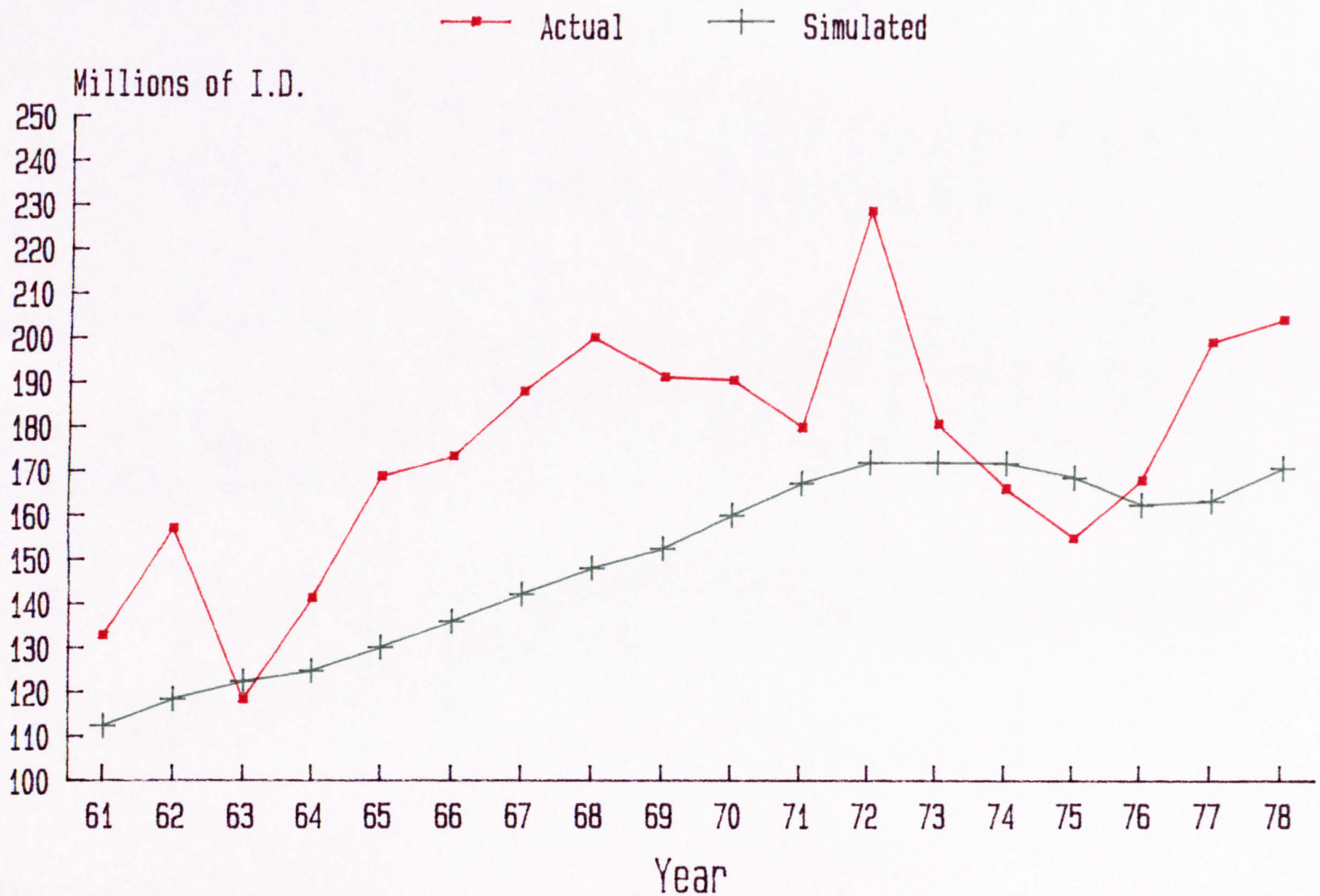
TABLE C.3.

Actual and simulated output levels for the Agricultural sector, 1961-1978.

YEAR (1)	Actual Ooutput (Million 1969 I.D) (2)	Simulated Output (Million 1969 I.D) (3)
1961	132.760	112.172
1962	157.130	118.298
1963	118.340	122.330
1964	141.300	124.706
1965	168.810	130.060
1966	173.200	135.967
1967	187.660	142.210
1968	199.940	147.996
1969	191.000	152.382
1970	190.310	159.897
1971	179.700	167.126
1972	228.600	171.773
1973	180.500	171.761
1974	166.000	171.556
1975	154.810	168.431
1976	167.800	162.169
1977	198.880	163.095
1978	204.140	170.575

1. The actual outputs of column (2) are from table C.1 column (2)
2. The simulated outputs are derived from the equation in table 6.6 using series of capital and of labour stated in table C.1.

Figure C.1 Actual and Simulated Output Levels for the Agricultural Sector, 1961-1978



Source: Table C.3

TABLE C.4

Capita stock and labour force data for the Agricultural sector used for prediction and predicted output levels, 1979-1990.

Year (1)	Labour Force (Thousnd Employed) (2)	Capital Stock (Million 1969 I.D) (3)	Predicted Output (Million 1969 I.D) (4)
1979	860.400	513.200	177.755
1980	786.100	566.100	173.613
1981	718.300	624.400	169.571
1982	656.300	688.700	165.617
1983	599.700	759.600	161.760
1984	547.900	837.800	157.980
1985	500.600	924.100	154.296
1986	457.400	1019.30	150.702
1987	417.900	1124.30	147.186
1988	381.800	1240.10	143.749
1989	348.800	1367.80	140.387
1990	318.700	1508.70	137.117

Notes:

1. Figures of capital stock in column (2) are derived by assuming growth rate of (10.3) percent.
2. Figures of labour force in column (3) are derived by assuming groth rate of (- 8.63) percent.
3. Predicted output levels derived by using equation in table 6.6.

TABLE C.5

Results of ordinary least squares estimation of the Agricaltural sector growth rates.

	ln α	ln β	R^2	SSR*	rate of growth
Value-added					
1960-1967	4.6860 (52.96)**	0.0663 (3.782)	0.70	0.0774	6.8509
1968-1972	5.0568 (14.75)	0.0269 (0.670)ns	0.13	0.0287	2.0909
1973-1978	4.5970 (12.02)	0.0354 (1.534)	0.37	0.0372	3.6007
1960-1978	4.9011 (69.39)	0.0224 (3.618)	0.44	0.3719	2.2665
Capital stock					
1960-1967	4.8529 (283.1)	0.0494 (14.54)	0.97	0.0029	5.0589
1968-1972	4.6452 (138.8)	0.0718 (23.75)	0.99	0.0003	7.4415
1973-1978	4.2631 (44.83)	0.0977 (17.05)	0.99	0.0023	10.268
1960-1978	4.7640 (175.4)	0.0659 (27.64)	0.98	0.0550	6.8071
Labour force					
1960-1967	6.5161 (475.6)	0.0677 (24.96)	0.99	0.0019	7.0073
1968-1972	6.7687 (172.2)	0.0411 (11.59)	0.98	0.0004	4.1950
1973-1978	8.5184 (51.57)	-0.0902 (-9.06)	0.95	0.0069	-8.6264
1960-1978	6.7847 (74.37)	0.0207 (2.593)	0.28	0.6203	2.0961

(Continued)

TABLE C.5 continued

	ln α	ln β	R^2	SSR	rate of growth
Total factor Inputs					
1960–1967	4.5412 (572.4)	0.0624 (39.70)	0.99	0.0062	6.4349
1968–1972	4.6602 (169.5)	0.0500 (20.15)	0.99	0.0078	5.1245
1973–1978	5.3988 (38.40)	−0.0086 $(-1.01)^{ns}$	0.20	0.0050	−0.8535
1960–1978	4.6774 (102.8)	0.0384 (9.629)	0.85	0.1542	3.9163
Kendrick's Index					
1960–1967	4.6697 (54.66)	0.0039 $(0.23)^{ns}$	0.01	0.0721	0.3909
1968–1972	4.9215 (13.51)	−0.0293 $(-0.89)^{ns}$	0.21	0.0323	−2.8858
1973–1978	3.7231 (10.74)	0.0439 (2.103)	0.53	0.0306	4.4926
1960–1978	4.7487 (85.71)	−0.0160 (−3.29)	0.39	0.2288	−1.5876
Solow's index					
1960–1967	4.6746 (51.35)	0.0036 $(0.198)^{ns}$	0.01	0.0819	0.3579
1968–1972	4.9517 (13.07)	−0.0324 $(-0.95)^{ns}$	0.23	0.0350	−3.1879
1973–1978	3.4598 (9.157)	0.0617 (2.701)	0.65	0.0364	6.3694
1960–1978	4.7361 (77.64)	−0.0138 (−2.57)	0.28	0.2774	−1.2669

(Continued)

TABLE C.5 Continued

	ln α	ln β	R^2	SSR	rate of growth
Capital <u>Productivity</u>					
1960-1967	-0.1229 (-1.86)	0.0169 (0.950)ns	0.13	0.0798	1.7057
1968-1972	0.4116 (1.198)ns	-0.0511 (-1.65)	0.47	0.0288	-4.9800
1973-1978	0.3339 (1.122)ns	-0.0624 (-3.48)	0.75	0.0225	-6.0495
1960-1978	0.1371 (1.581)	-0.0434 (-5.71)	0.66	0.5607	-4.2511
Labour <u>Productivity</u>					
1960-1967	-1.8302 (-21.6)	-0.0015 (-0.09)ns	0.00	0.0712	-0.1462
1968-1972	-1.7119 (-4.57)	-0.0204 (-0.60)ns	0.11	0.0342	-2.0195
1973-1978	-3.9213 (-8.86)	0.1256 (4.705)	0.85	0.0499	13.381
1960-1978	-1.8836 (-23.8)	0.0017 (0.240)ns	0.00	0.4672	0.1670
Capital labour <u>Ratio</u>					
1960-1967	-1.6633 (-60.3)	-0.1838 (-3.37)	0.65	0.0075	-1.8208
1968-1972	-2.1235 (-38.1)	0.0307 (6.107)	0.93	0.0008	3.1157
1973-1978	-4.2553 (-24.9)	0.1880 (18.27)	0.99	0.0074	20.678
1960-1978	-2.0207 (-17.3)	0.4511 (4.403)	0.53	1.0172	4.6143

Notes:

* Stand for the sum squared of residual.

** Stand for t values.

ns Stand for not significant.

Equation used as that mantiond in notes of table B.1.

Sources: calculated from data in tables B.1,B.2,B.6 and 6.4.

APPENDIX D

TABLE D.1.

Production function data for the Manufacturing sector, 1960-1978.

Year	Q Ooutput (Million 1969 I.D)	L Labour (Thousnd Employed)	K Capital stock (Million 1969 I.D)
1960	60.1820	130.000	125.960
1961	67.5400	130.000	132.600
1962	73.7410	130.000	143.180
1963	69.5130	130.000	162.290
1964	67.5440	130.000	180.840
1965	76.4560	135.000	199.830
1966	79.1810	140.000	221.500
1967	81.3760	140.000	247.560
1968	95.6460	146.000	275.530
1969	103.000	148.000	304.120
1970	117.900	154.100	335.090
1971	122.510	171.400	366.490
1972	132.660	182.200	393.940
1973	143.490	180.500	429.720
1974	153.710	182.800	480.420
1975	206.940	236.600	551.410
1976	277.150	228.200	662.030
1977	365.610	245.900	759.750
1978	354.830	249.100	885.560

Sources:

1. Output figures are from table A.1 and deflated by their implict price deflator stated in table A.2.
2. Capital stock figures are calculated from the figures in table A.5
3. figures on labour force for the years 1960 -1970 are from statistical pocketbook (1970), table 10, p 27, Ministry of planning; For the years 1970-1973 are from Annual Abstract of Statistics (1973), table 208, p358, Ministry of planning; And for the years 1974-1978 are from Annual Abstract of Statistics (1979), table 4/1, p 95 and table 4/9, p 113.

TABLE D.2.

Capital productivity, labour productivity and capital labour ratio for the Manufacturing sector, 1960-1978.

Year	Capital Productivity Q/K	Labour Productivity Q/L	Capital/Labour Ratio K/L
1960	0.47778	0.46293	0.96892
1961	0.50935	0.51953	1.02000
1962	0.51502	0.56723	1.10138
1963	0.42832	0.53471	1.24838
1964	0.37350	0.51956	1.39108
1965	0.38260	0.56634	1.48022
1966	0.35747	0.56557	1.58214
1967	0.32871	0.58125	1.76829
1968	0.34713	0.65511	1.88719
1969	0.33868	0.69594	2.05486
1970	0.35184	0.76508	2.17450
1971	0.33427	0.71476	2.13821
1972	0.33675	0.72810	2.16213
1973	0.33391	0.79495	2.38072
1974	0.31994	0.84086	2.62812
1975	0.37529	0.87464	2.33056
1976	0.41863	1.21450	2.90110
1977	0.48122	1.48682	3.08967
1978	0.40068	1.42445	3.55504

Data Sources: Compiled from data in table D.1.

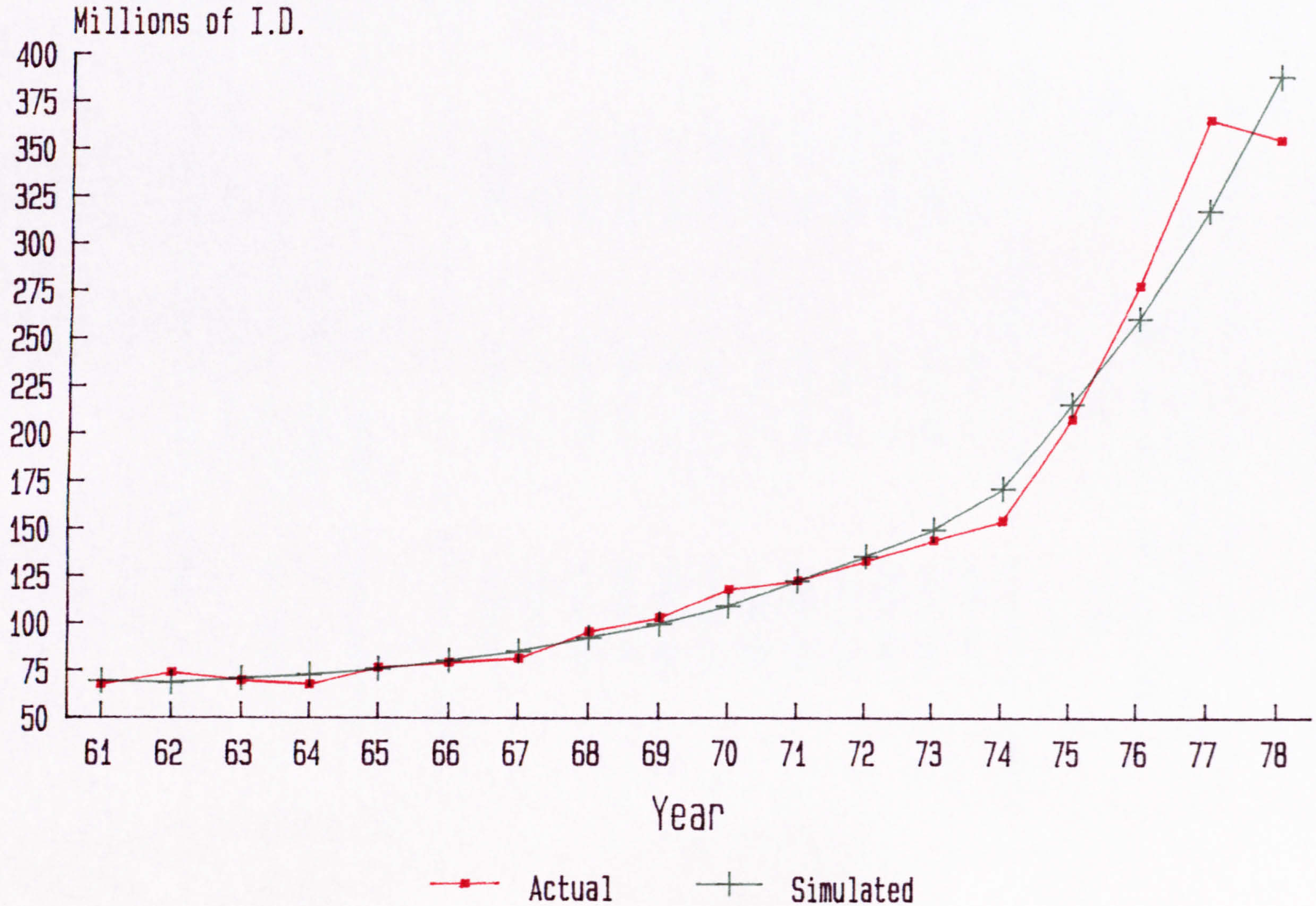
TABLE D.3.

Actual and simulated output levels for the Manufacturing sector, 1961–1978.

Year (1)	Actual Output (Million 1969 I.D) (2)	Simulated Output (Million 1969 I.D) (3)
1961	67.5400	69.0600
1962	73.7410	68.1752
1963	69.5130	70.3872
1964	67.5440	72.4917
1965	76.4560	75.7351
1966	79.1810	80.0536
1967	81.3760	85.0989
1968	95.6460	92.1519
1969	103.000	99.3839
1970	117.900	108.916
1971	122.510	122.125
1972	132.660	134.857
1973	143.490	149.035
1974	153.710	170.350
1975	206.940	214.582
1976	277.150	259.786
1977	365.610	317.088
1978	354.830	388.515

1. The actual outputs of column (2) are from table D.1 column (2).
2. The simulated outputs are derived from the equation in table 7.9 using series of labour and of capital stated in table D.1.

Figure D.1 Actual and Simulated Output Levels for the Manufacturing Sector, 1961-1978



Source: Table D.3

TABLE D.4.

Capital stock and labour force data for the Manufacturing sector used For prediction and predicted output levels, 1979-1990

Year (1)	Labour Force (Thousnd Employed) (2)	Capital Stock (Million 1969 I.D) (3)	Predicted Output (Million 1969 I.D) (4)
1979	267.300	1026.40	486.530
1980	286.800	1189.60	615.259
1981	307.700	1378.70	785.697
1982	330.200	1597.90	1013.35
1983	354.300	1852.00	1319.85
1984	380.200	2146.50	1736.08
1985	408.000	2487.80	2306.13
1986	437.800	2883.40	3093.58
1987	469.800	3341.90	4190.97
1988	504.100	3873.30	5733.59
1989	540.900	4489.10	7921.37
1990	580.400	5202.90	11052.3

Notes:

1. Figures of capital stock in column (2) are derived by assuming growth rate of 15.9 percent.

2. Figures of labour force in column (3) are derived by assuming growth rate of 7.29 percent.

3. Pedicted outputs derived by using equation stated in table 6.9.

TABLE D.5.

Results of ordinary least squares estimation of the Manufacturing sector growth rates.

	ln α	ln β	R^2	SSR*	rate of growth
Value-Added					
1960-1967	4.1116 (100.8)**	0.0356 (4.402)	0.76	0.0164	3.6196
1968-1972	3.8217 (44.32)	0.0828 (10.47)	0.97	0.0246	8.6296
1973-1978	2.4658 (5.812)	0.2120 (8.288)	0.94	0.0458	23.609
1960-1978	4.3183 (49.24)	0.0956 (12.43)	0.90	0.5732	10.033
Capital stock					
1960-1967	4.6978 (271.0)	0.1000 (29.14)	0.99	0.0030	10.522
1968-1972	4.8144 (140.8)	0.0902 (29.24)	0.99	0.0003	9.4344
1973-1978	3.9720 (52.99)	0.1478 (32.71)	0.99	0.0014	15.929
1960-1978	4.6633 (196.1)	0.1057 (50.65)	0.99	0.0427	11.145
Labour force					
1960-1967	4.8371 (331.6)	0.0119 (4.131)	0.74	0.0021	1.2006
1968-1972	4.4247 (42.10)	0.0590 (6.223)	0.93	0.0027	6.0752
1972-1978	4.2256 (14.73)	0.0704 (4.070)	0.81	0.0209	7.2939
1960-1978	4.6992 (124.8)	0.0396 (12.01)	0.89	0.1057	4.0445

(Continued)

Table D.5 Continued

	ln α	ln β	R^2	SSR	rate of growth
Total factor Inputs					
1960-1967	4.4922 (262.3)	0.0760 (22.40)	0.99	0.0039	7.8939
1968-1972	4.4540 (212.3)	0.0842 (44.49)	0.99	0.0060	8.7797
1973-1978	3.6826 (60.10)	0.1366 (36.98)	0.99	0.0010	14.639
1960-1978	4.4109 (155.5)	0.0915 (36.79)	0.99	0.0599	9.5818
Kendrick's Index					
1960-1967	4.7324 (93.19)	-0.0404 (-4.02)	0.73	0.0255	-3.9616
1968-1972	4.4807 (51.32)	-0.0014 $(-0.18)^{ns}$	0.02	0.0019	-0.1320
1973-1978	3.3883 (8.663)	0.0753 (3.195)	0.72	0.0389	7.8253
1960-1978	4.5126 (71.14)	0.0041 $(0.735)^{ns}$	0.13	0.2999	0.4117
Solow's index					
1960-1967	4.6958 (79.41)	-0.0285 (-2.43)	0.50	0.0345	-2.8079
1968-1972	4.5616 (43.02)	0.0015 $(0.152)^{ns}$	0.01	0.0027	0.1452
1973-1978	3.2078 (7.561)	0.0967 (3.782)	0.78	0.0458	10.1574
1960-1978	4.4721 (66.69)	0.0172 (2.931)	0.34	0.3352	1.7387

(Continued)

Table D.5 Continued

	ln α	ln β	R^2	SSR	Rate of growth
Capital Productivity					
1960–1967	–5.5862 (–10.8)	–0.0645 (–6.01)	0.86	0.0290	-6.2451
1968–1972	–0.9927 (–13.4)	–0.0074 (–1.11)ns	0.29	0.0211	-0.7355
1973–1978	–2.0150 (–4.99)	0.0642 (2.634)	0.63	0.0415	6.6252
1960–1978	–0.8528 (–11.9)	–0.0101 (11.60)	0.13	0.3815	-1.0006
Labour Productivity					
1960–1967	–0.7255 (–18.3)	0.0236 (3.009)	0.60	0.0155	2.3903
1968–1972	–0.6030 (–3.45)	0.0238 (1.508)	0.43	0.0075	2.4080
1973–1978	–2.2677 (–5.55)	0.1416 (5.746)	0.89	0.0425	15.206
1960–1978	–0.8887 (–14.5)	0.0560 (10.41)	0.86	0.2803	5.7558
Capital/labour Ratio					
1960–1967	–0.1393 (–8.32)	0.0881 (26.56)	0.99	0.0028	9.2106
1968–1972	0.3897 (2.996)	0.0312 (2.658)	0.70	0.00413	3.1668
1973–1978	–0.2536 (–0.78)ns	0.0774 (3.950)	0.80	0.0269	8.0480
1960–1978	–0.0359 (–1.07)ns	0.0660 (22.54)	0.97	0.0831	6.8248

Notes:
- * stand for the sum squared of residuals.
- ** t-ratios.
- ns not significant.

Equation used as stated in table B.5.

Sources: calculated from figures in tables D.1,D.2,6.7 and 6.8.

APPENDIX E

TABLE E.1.

Production function data for the Mining and Quarrying sector, 1960-1978.

year	Q output (million 1969 I.D)	L labour (thousnd employed)	K capital stock (million I.D)
1960	232.200	11.0000	75.8800
1961	239.760	11.5000	102.770
1962	237.490	12.0000	127.630
1963	264.720	12.5000	133.130
1964	291.720	13.0000	135.000
1965	315.140	13.5000	135.990
1966	322.570	14.0000	137.200
1967	264.220	14.5000	138.740
1968	346.030	15.0000	140.170
1969	343.200	15.5000	141.380
1970	319.890	16.0000	142.480
1971	328.700	16.5000	149.740
1972	333.010	17.5000	159.640
1973	457.790	18.5000	171.960
1974	441.610	19.2000	200.310
1975	464.440	20.0000	254.390
1976	696.290	32.9000	299.880
1977	695.100	36.7000	371.350
1978	827.530	35.5000	410.330

Sources:

1. Output figures are from table A.1 and deflated by their implict price deflator in table A.2.
2. Capital stock figures are calculated from the figures in table A.5
3. Figures on labour force for the years 1960 to 1970 are taken from Statistical pocketbook (1970), table 10 p 27; for the years 1971-1973 are taken from Annual Abstract of Statistics 1973, table 208, p 358; And for the years 1974-1978 are taken from Ahmed (1978), table I.1, p 270.

TABLE E.2.

Capital prodactivity, labour prodactivity and Capital/ Labour ratio for the Mining and Quarrying sector.

year	capital productivity Q/K	labour productivity Q/L	capital/labour ratio K/L
1960	3.06009	21.1091	6.89818
1961	2.33298	20.8487	8.93652
1962	1.86077	19.7908	10.6358
1963	1.98843	21.1776	10.6504
1964	2.16089	22.4400	10.3846
1965	2.31738	23.3437	10.0733
1966	2.35109	23.0407	9.80000
1967	1.90443	18.2221	9.56828
1968	2.46865	23.0687	9.34467
1969	2.42750	22.1419	9.12129
1970	2.24516	19.9931	8.90500
1971	2.19514	19.9212	9.07515
1972	2.08601	19.0291	9.12229
1973	2.66219	24.7454	9.29514
1974	2.20463	23.0005	10.4328
1975	1.82570	23.2220	12.7195
1976	2.32190	21.1638	9.11489
1977	1.87182	18.9401	10.1185
1978	2.01674	23.3107	11.5586

Sources: Compiled from table E.1.

TABLE E.3.

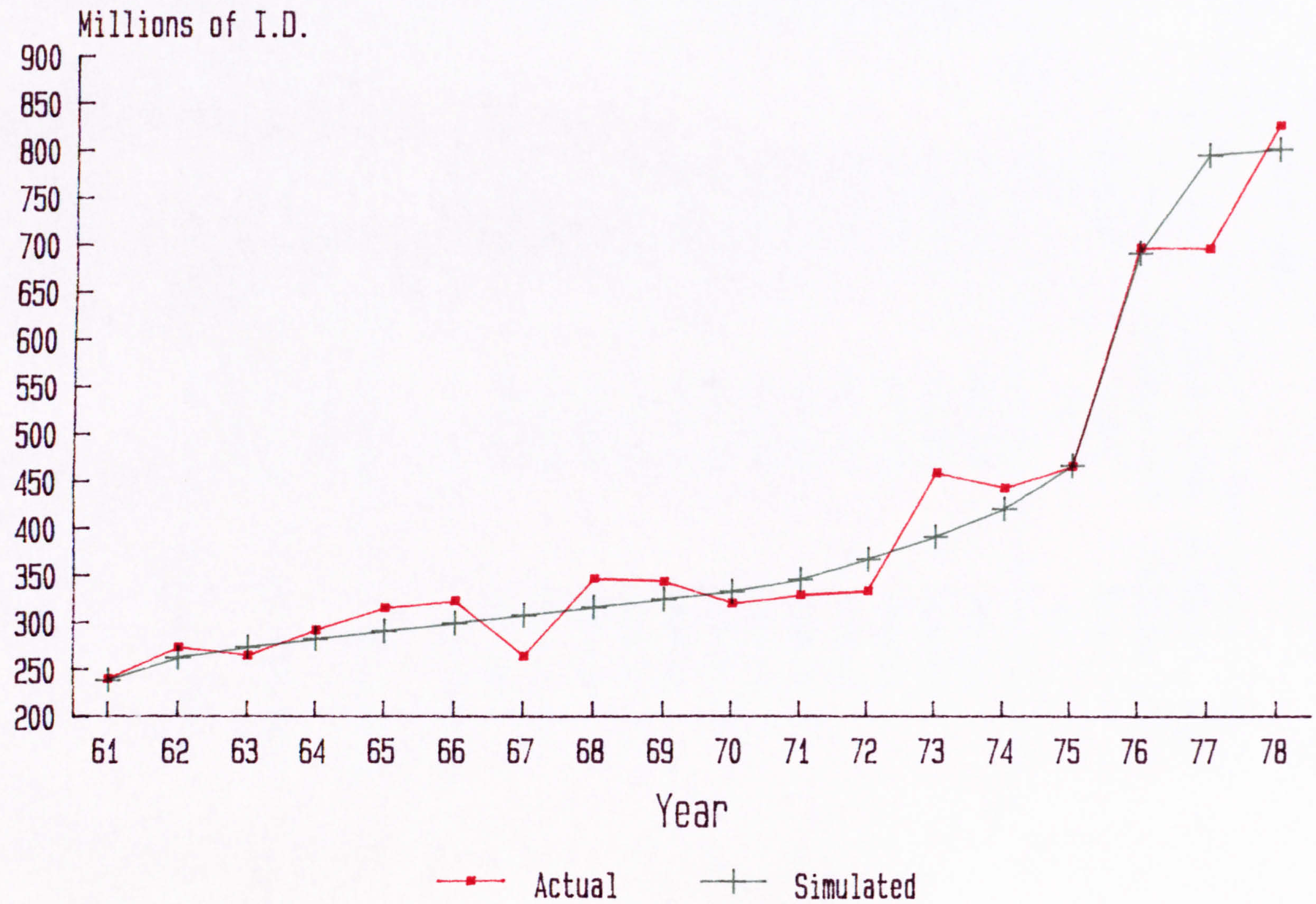
Actual and simulated output levels for the Mining and Quarrying sector, 1961-1978.

year (1)	actual output (million 1969 I.D) (2)	Simulated output (million 1969 I.D) (3)
1961	239.760	237.803
1962	237.490	261.976
1963	264.720	273.157
1964	291.720	282.032
1965	315.140	290.303
1966	322.570	298.675
1967	264.220	307.236
1968	346.030	315.694
1969	343.200	323.970
1970	319.890	332.137
1971	328.700	344.711
1972	333.010	366.389
1973	457.790	389.789
1974	441.610	419.437
1975	464.440	464.712
1976	696.290	690.157
1977	695.100	795.520
1978	827.530	802.192

Notes:

1. The actual outputs of column (2) are from table E.1, column (2).
2. The simulated outputs are derived from the equation in table 7.12 usinig series of capital and of labour stated in table E.1.

Figure E.1 Actual and Simulated Output Levels for the Mining and Quarrying Sector, 1961-1978



Source: Table E.3

TABLE E.3.

Capital stock and Labour force data for the Mining and Quarrying sector used for prediction and predicted output levels, 1979-1990.

year (1)	labour force (thousnd employed) (2)	capital stock (million 1969 I.D) (3)	predicted output (million 1969 I.D) (4)
1979	41.8000	491.900	950.384
1980	49.2000	589.800	1125.66
1981	57.9000	707.200	1333.11
1982	68.1000	847.900	1578.13
1983	80.2000	1016.60	1869.86
1984	94.4000	1218.90	2214.73
1985	111.100	1461.50	2622.99
1986	130.800	1752.30	3107.21
1987	153.900	2101.00	3679.31
1988	181.100	2519.10	4357.09
1989	213.200	3020.40	5161.27
1990	250.900	3621.50	6112.39

Notes:

1. Figures of capital stock in column (2) are derived by assuming growth rate of 19.9 percent.

2. Figures of labour force in column (3) are derived by assuming growth rate of 17.7 percent.

3. Predicted output levels derived by using equation in table 6.15.

TABLE E.5.

Results of ordinary least squares estimation of the Mining and Quarrying sector growth rates.

	ln α	ln β	R^2	SSR*	rate of growth
Value-Added					
1960-1967	5.4162 (76.56)**	0.3968 (2.833)	0.57	0.0495	4.0482
1968-1972	5.9431 (76.56)	-0.0112 (2.833)	0.35	0.0299	-1.1916
1973-1978	4.1330 (9.050)	0.1350 (4.905)	0.86	0.0531	14.457
1960-1978	5.2818 (70.61)	0.6119 (9.326)	0.84	0.4171	6.3096
Capital stock					
1960-1967	4.4821 (42.25)	0.0699 (3.329)	0.65	0.1112	7.2421
1968-1972	4.6377 (54.57)	0.0318 (4.145)	0.85	0.0018	3.2268
1973-1978	2.6033 (18.41)	0.1819 (21.33)	0.99	0.0051	19.944
1960-1978	4.4198 (49.90)	0.0682 (8.777)	0.82	0.5848	7.0567
Labour force					
1960-1967	2.3642 (737.4)	0.0394 (62.07)	0.99	0.0001	4.0190
1968-1972	2.3695 (69.51)	0.0371 (12.06)	0.98	0.0003	3.8546
1973-1978	0.5685 (0.992)ns	0.1629 (4.713)	0.85	0.0836	17.687
1960-1978	2.2342 (31.42)	0.0595 (9.540)	0.84	0.3768	6.1298

(Continued)

Table E.5 continued

	ln α	ln β	R^2	SSR	rate of growth
Total factor Inputs					
1960-1967	4.6387 (113.4)	0.0502 (6.195)	0.86	0.0165	5.1446
1968-1972	4.6953 (92.65)	0.0351 (7.652)	0.95	0.0145	3.3568
1973-1978	2.8016 (7.832)	0.1705 (7.907)	0.94	0.0326	18.593
1960-1978	4.5303 (61.76)	0.0628 (9.764)	0.85	0.4011	6.4838
Kendrick's Index					
1960-1967	4.5402 (59.92)	-0.0105 (-0.70)^{ns}	0.08	0.0567	-1.0428
1968-1972	5.0106 (7.554)	-0.0470 (-7.35)	0.95	0.0012	-4.5956
1973-1978	5.0941 (15.89)	-0.0355 (-1.84)	0.46	0.0261	-3.4879
1960-1978	4.5142 (107.1)	-0.0016 (-0.44)^{ns}	0.01	0.1323	-0.1635
Solow's index					
1960-1967	4.5369 (57.66)	-0.0128 (-0.82)^{ns}	0.10	0.0612	-1.2723
1968-1972	5.0053 (66.79)	-0.0491 (-7.26)	0.95	0.0014	-4.7901
1973-1978	5.2433 (16.02)	-0.0466 (-2.36)	0.58	0.0272	-4.5508
1960-1978	4.5110 (100.0)	-0.0365 (-0.92)^{ns}	0.05	0.1516	-0.3648

(Continued)

Table E.5 continued

	ln α	ln β	R^2	SSR	rate of growth
Capital Productivity					
1960-1967	0.9340 (7.855)	-0.0302 (-1.28)ns	0.22	0.1397	-2.9782
1968-1972	1.3054 (24.44)	-0.4375 (-9.08)	0.96	0.0007	-4.5802
1973-1978	1.5297 (3.063)	-0.4682 (-1.55)	0.38	0.06344	-4.5745
1960-1978	0.8620 (13.95)	-0.0029 (-1.29)ns	0.09	0.2846	-0.6979
Labour Productivity					
1960-1967	3.0520 (44.08)	0.0003 (0.021)ns	0.00	0.0474	0.0281
1968-1972	3.5736 (40.62)	-0.0491 (-6.19)	0.93	0.0019	-4.7886
1973-1978	3.5645 (10.17)	-0.0278 (-1.32)ns	0.30	0.0312	-2.7449
1960-1978	3.0477 (72.37)	0.0017 (0.458)ns	0.01	0.1322	0.1695
Capital/Labour Ratio					
1960-1967	2.1180 (20.54)	0.0305 (1.494)	0.57	0.1051	3.0985
1968-1972	2.2682 (37.36)	-0.0053 (-0.973ns	0.24	0.0009	-0.5310
1973-1978	2.0345 (3.725)	0.0190 (0.577)ns	0.08	0.07591	1.9173
1960-1978	2.1857 (38.44)	0.0087 (1.744)	0.15	0.2410	0.8734

Notes:
* stand for the sum squared of residuals
** t-ratios
ns not significant
Equation used as that stated in footnotes of table B.5.
Sources: calculated from figures in tables E.1,E.2,6.10 and 6.11.

APPENDIX F

TABLE F.1.

Production function data for the Electricity, Gas and Water sector, 1960-1978.

year (1)	Q output (million 1969 I.D) (2)	L labour (thousnd eployed) (3)	K capital stock (million 1969 I.D) (4)
1960	4.01000	11.8000	36.3000
1961	5.63000	11.9000	44.8000
1962	6.20000	12.0000	50.3900
1963	5.63000	12.0000	55.3700
1964	11.7700	12.0000	63.5400
1965	13.2300	12.0000	76.0600
1966	13.3600	12.2000	87.6900
1967	13.5100	12.4000	100.000
1968	15.1200	12.6000	113.080
1969	16.8000	12.8000	121.920
1970	17.8000	12.9000	130.420
1971	11.9000	13.0000	142.270
1972	13.7000	14.6000	152.900
1973	16.0000	16.1000	163.070
1974	18.6000	17.0000	172.180
1975	22.7400	18.3000	177.220
1976	25.3700	20.3000	214.030
1977	27.7200	22.8000	250.670
1978	41.4900	26.1000	271.970

sources:

1. Output figures are from table A.1 and deflated by their implict price deflator in table A.2.
2. Capital stock figures are calculated from the figures in table A.5
3. Figures on number of persons employed for the period 1960 -1970 are from Statistical pocketbook (1972), table 10, p 27; For the period 1971-1974 are from Annual Abstract of Statistics (1973), table 208, p 358; For the years 1974-1976 are from Annual Abstract of Statistics (1976), table 4/16, p 164; for the year 1977 from Annual Abstract of Statistics 1978, table 16/4, p 1978. And for the year 1978 from Annual Abstract of Statistics (1982), table 12/4, p 108.

TABLE F.2.

Capital productivity, Labour productivity and capital/Labor ratio for the Electricity, Gas, and Water sector.

year	capital productivity Q/K	labour productivity Q/L	capital/labour ratio K/L
1960	0.11047	0.33983	3.07627
1961	0.12567	0.47311	3.76471
1962	0.12304	0.51667	4.19917
1963	0.10168	0.46917	4.61417
1964	0.18524	0.98083	5.29500
1965	0.17394	1.10250	6.33833
1966	0.15235	1.09508	7.18770
1967	0.13510	1.08952	8.06452
1968	0.13371	1.20000	8.97460
1969	0.13780	1.31250	9.52500
1970	0.13648	1.37984	10.1101
1971	0.08364	0.91538	10.9438
1972	0.08960	0.93836	10.4726
1973	0.09812	0.99379	10.1286
1974	0.10803	1.09412	10.1282
1975	0.12831	1.24262	9.68415
1976	0.11853	1.24975	10.5433
1977	0.11058	1.21579	10.9943
1978	0.15255	1.58966	10.4203

Sources: Compiled from data in table F.1

TABLE F.3.

Actual and simulated output levels for the Electricity, Gas and Water sector, 1961-1978.

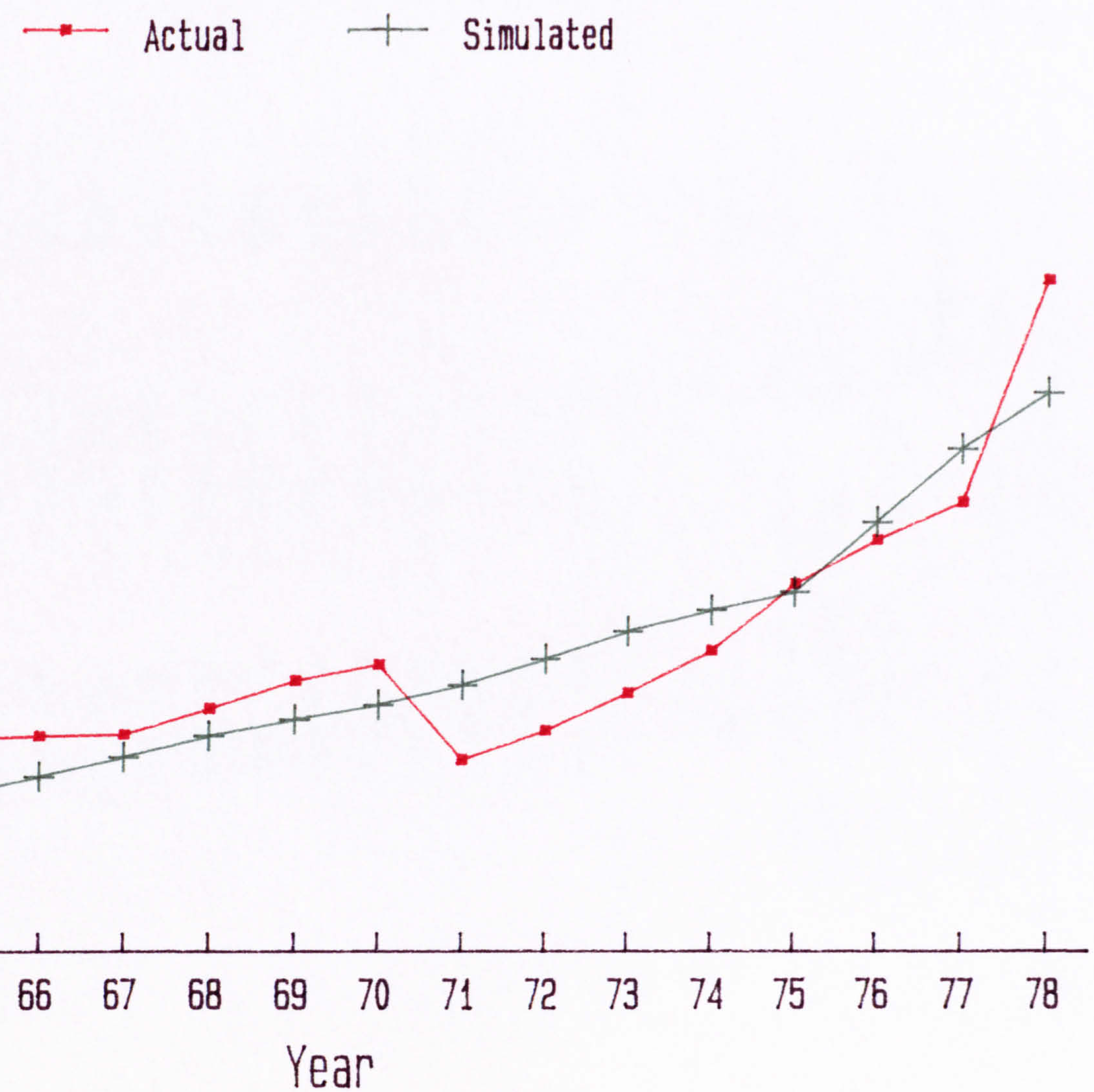
year (1)	actual output (million 1969 I.D) (2)	simulated output (million 1969 I.D) (3)
1961	5.63000	6.36584
1962	6.20000	7.00964
1963	5.63000	7.57405
1964	11.7700	8.43751
1965	13.2300	9.68277
1966	13.3600	10.8752
1967	13.5100	12.1200
1968	15.1200	13.4263
1969	16.8000	14.3820
1970	17.8000	15.2845
1971	11.9000	16.4686
1972	13.7000	18.1326
1973	16.0000	19.7501
1974	18.6000	21.0874
1975	22.7400	22.2417
1976	25.3700	26.4863
1977	27.7200	30.9810
1978	41.4900	34.5352

Notes:

1. The actual outputs of column (2) are from table E.1, column (2).

2. The simulated outputs are derived from the equation in table 7.12 usinig series of capital and of labour stated in table E.1.

Figure F.1 Actual and Simulated Output Levels for the Electricity, Gas and Water Sector, 1961-1978



Source: Table F.3

Table F.4.

Capital stock and Labour force data for the Electricity, Gas and Water sector used for prediction and predicted output levels, 1979-1990.

year (1)	labour force (thousnd emloyed) (2)	capital stock (million 1969 I.D) (3)	predicted output (million 1969 I.D) (4)
1979	28.8000	303.800	39.1415
1980	31.7000	339.300	44.0302
1981	34.9000	379.000	49.5376
1982	38.5000	423.300	55.7628
1983	42.4000	472.800	62.7410
1984	46.7000	528.100	70.5959
1985	51.5000	589.900	79.4663
1986	56.8000	658.900	89.4514
1987	62.6000	736.000	100.672
1988	69.0000	822.100	113.302
1989	76.0000	918.300	127.493
1990	83.8000	1025.70	143.501

Notes:

1. Figures of capital stock in column (2) are derived by assuming growth rate of 10.2 percent.
2. Figures of labour force in column (3) are derived by assuming growth rate of 11.7 percent.
3. Predicted outputs levels derived by using equation in table 6.12.

TABLE F.5.

Results of ordinary least squares estimation of the Electricity, Gas and Water sector growth rates.

	ln α	ln β	R^2	SSR*	rate of growth
Value-added					
1960-1967	1.2659 (8.363)**	0.1885 (6.289)	0.87	1.2659	20.745
1968-1972	3.2984 (5.970)	-0.0542 (-1.09)ns	0.28	0.0745	-5.2766
1973-1978	0.3215 (0.951)ns	0.1735 (8.505)	0.95	0.0291	18.940
1960-1978	1.6407 (13.87)	0.0966 (9.309)	0.84	1.0432	10.141
Capital stock					
1960-1967	3.4778 (158.5)	0.1408 (32.40)	0.99	0.0048	15.116
1968-1972	4.0444 (235.3)	0.0758 (48.88)	0.99	0.0001	7.8719
1960-1967	3.4935 (16.19)	0.1107 (8.505)	0.95	0.0119	11.702
1960-1978	3.6497 (87.28)	0.1045 (28.49)	0.98	0.1303	11.013
Labour force					
1960-1967	2.4627 (444.2)	0.0056 (5.114)	0.81	0.0003	0.5631
1968-1972	2.2361 (16.70)	0.0310 (2.569)	0.69	0.0044	3.1501
1973-1978	1.3835 (11.11)	0.0971 (12.94)	0.98	0.0039	10.202
1960-1978	2.2806 (40.70)	0.0388 (7.900)	0.79	0.2341	3.9592

(Continued)

Table f.5 continued

	ln α	ln β	R^2	SSR	rate of growth
Total factor <u>Inputs</u>					
1960-1967	4.4953 (226.1)	0.1258 (31.93)	0.99	0.0039	13.403
1968-1972	4.9640 (268.3)	0.7313 (43.83)	0.99	0.0053	7.5867
1973-1978	4.3945 (21.07)	0.1099 (8.740)	0.95	0.0111	11.617
1960-1978	4.6236 (137.7)	0.0986 (33.47)	0.99	0.0841	10.360
kendrick's <u>Index</u>					
1960-1967	4.5921 (30.60)	0.0628 (2.112)	0.43	0.2225	6.4763
1968-1972	6.1560 (10.88)	-0.1273 (-2.49)	0.67	0.0781	-11.956
1973-1978	3.7473 (8.597)	0.0636 (2.422)	0.59	0.0483	6.5710
1960-1978	4.8386 (46.92)	-0.0020 (-0.22)ns	0.00	0.7926	-0.1988
<u>Solow,s index</u>					
1960-1967	4.5919 (27.36)	0.0741 (2.231)	0.45	0.2783	7.6949
1968-1972	6.4270 (10.14)	-0.1277 (-2.59)	0.69	0.0979	-13.735
1973-1978	3.7606 (8.165)	0.0650 (2.339)	0.58	0.0540	6.7111
1960-1978	4.8894 (42.11)	-0.0026 (-0.25)ns	0.00	1.0049	-0.2585

(Continued)

Table F.5 continued

	ln α	ln β	R^2	SSR	rate of growth
<u>Capital Productivity</u>					
1960-1967	11.604 (78.25)	0.0477 (1.626)	0.31	0.2173	4.8899
1968-1972	53.135 (3.345)	-4.2746 (2.985)	0.75	61.537	-98.604
1973-1978	6.0385 (0.196)ns	0.0628 (0.033)ns	0.00	252.61	6.4799
1960-1978	13.261 (5.062)	-0.4442 (-1.93)	0.18	511.63	-35.865
<u>Labour Productivity</u>					
1960-1967	-1.1967 (-7.73)	0.1829 (5.965)	0.86	0.2369	20.068
1968-1972	1.0623 (1.953)	-0.0852 (-1.74)	0.50	0.0722	-8.1693
1973-1978	-1.0620 (-3.53)	0.0763 (4.212)	0.82	0.0230	7.9296
1960-1978	-0.6399 (-4.73)	0.0578 (4.867)	0.58	1.3649	5.9459
Capital/labour <u>Ratio</u>					
1960-1967	1.0152 (47.86)	0.1352 (32.18)	0.99	0.0044	14.471
1968-1972	1.8083 (13.45)	0.0448 (3.693)	0.82	0.0044	4.5775
1973-1978	2.1099 (13.63)	0.0135 (1.448)	0.34	0.0061	1.3610
1960-1978	1.3691 (15.41)	0.0657 (8.427)	0.81	0.5881	6.7858

Notes
- * stand for the sum squared of residuals
- ** t-ratios
- NS not significantt

Equation used as that stated in footnotes of table B.1.
Sources: calculated from data in tables F.1,F.2,6.12 and 6.13.

APPENDIX G

TABLE G.1.

Production function data for the Construction sector, 1960-1978.

year (1)	Q output (million 1969 I.D) (2)	L labour (thousnd emloyed) (3)	K capital stock (million 1969 I.D) (3)
1960	25.5400	58.0000	12.6500
1961	27.1000	58.1000	13.8700
1962	21.9900	50.0000	15.6200
1963	21.9900	43.1000	17.1000
1964	28.3100	47.2000	17.8400
1965	33.6000	61.1000	18.7900
1966	36.5700	70.0000	20.2900
1967	32.0200	59.1000	22.1900
1968	37.3400	66.0000	24.0400
1969	38.5000	67.0000	25.0300
1970	38.9000	67.0000	28.2800
1971	40.0000	72.8000	31.3200
1972	42.3000	69.2000	35.3000
1973	51.1000	71.0000	39.0400
1974	52.7000	73.0100	44.6700
1975	69.1000	90.6000	58.4100
1976	184.000	113.000	76.3500
1977	178.700	150.600	99.5100
1978	243.600	185.600	114.790

Sources:

1. Output figures are from table A.1 and deflated by their implict price deflator in table A.2.
2. Capital stock figures are calculated from the figures in table A.5
3. Figures on number of employees for the years 1960-1970 are taken from Statistical pocketbook (1972), table 10, p 27; for the years 1971-1974 are taken from statistical Abstract of the Arab World (1979), ECWA, UN; For the years 1975-1976 from Annual Abstract of Statistics (1977), table 5 /5, p 116, and table 5/12, p 122;And for the years 1977 and 1978 are taken from Annual Abstract of Statistics (1979), table 13/9, p 270 and table 13/ 16 p 276.

TABLE G.2.

Capital productivity, Labour productivity and Capital/ Labour ratio for the Construction sector.

year	capital productivity Q/K	labour productivity Q/L	capital/labour ratio K/L
1960	2.01897	0.44035	0.21810
1961	1.95386	0.46644	0.23873
1962	1.40781	0.43980	0.31240
1963	1.28596	0.51021	0.39675
1964	1.58688	0.59979	0.37797
1965	1.78819	0.54992	0.30753
1966	1.80237	0.52243	0.28986
1967	1.44299	0.54179	0.37546
1968	1.55324	0.56576	0.36424
1969	1.53815	0.57437	0.37358
1970	1.37553	0.58058	0.42209
1971	1.27714	0.54945	0.43022
1972	1.19830	0.61127	0.51012
1973	1.30891	0.71972	0.54986
1974	1.17976	0.72172	0.61183
1975	1.18302	0.76269	0.64470
1976	2.40995	1.62832	0.67566
1977	1.79580	1.18659	0.66076
1978	2.12214	1.31250	0.61848

Source: Compiled from the data in table G.1.

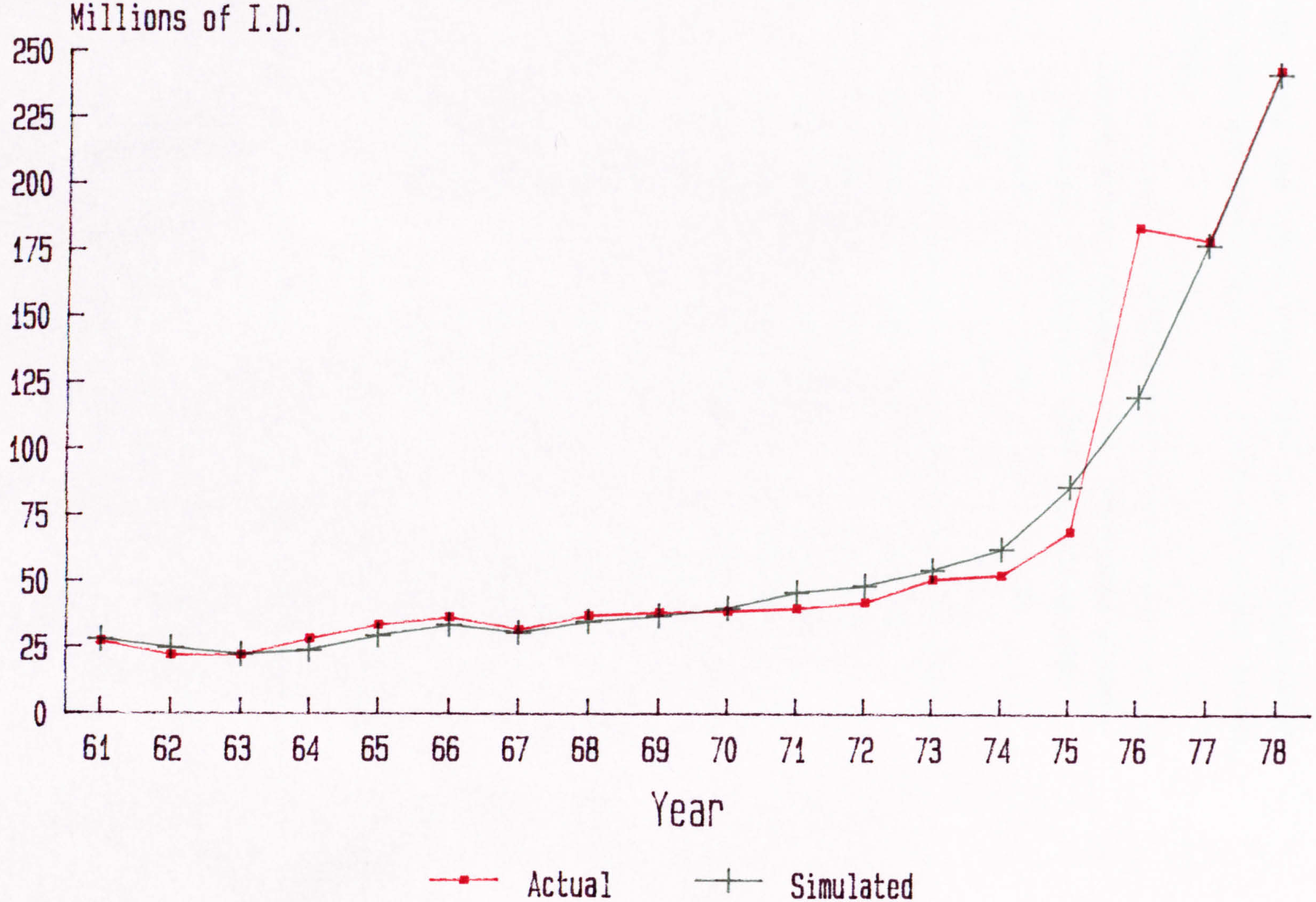
TABLE G.3.

Actual and simulated output levels for the Construction sector, 1961-1978.

year (1)	actual output (million 1969 I.D) (2)	simulated output (million 1969 I.D) (3)
1961	27.1000	27.6624
1962	21.9900	24.6912
1963	21.9900	22.1212
1964	28.3100	23.7657
1965	33.6000	29.3586
1966	36.5700	33.5148
1967	32.0200	30.6313
1968	37.3400	34.9396
1969	38.5000	37.0325
1970	38.9000	39.9024
1971	40.0000	46.0261
1972	42.3000	48.5409
1973	51.1000	54.5376
1974	52.7000	62.4286
1975	69.1000	85.9250
1976	184.000	119.794
1977	178.700	177.210
1978	243.600	242.130

1. The actual outputs of column (2) are from table G.1, column (2).
2. The simulated outputs are derived from the equation in table 7.16 usinig series of capital and of labour stated in table G.1.

Figure 6.1 Actual and Simulated Output Levels for the Construction Sector, 1961-1978



Source: Table 6.3

TABLE G.4.

Capital stock and Labour force data for the Construction sector used for prediction and predicted output levels, 1979-1990.

year (1)	labour force (thousnd emloyed) (2)	capital stock (million 1969 I.D) (3)	predicted output (million 1969 I.D) (4)
1979	227.900	144.500	339.721
1980	279.900	181.900	481.049
1981	343.700	229.000	687.265
1982	422.100	288.300	990.897
1983	518.300	363.000	1441.49
1984	636.500	457.000	2116.15
1985	781.600	575.400	3134.65
1986	959.800	724.400	4685.45
1987	1178.60	912.000	7066.89
1988	1447.30	1148.20	10755.6
1989	1777.30	1445.60	16518.5
1990	2182.50	1820.00	25599.0

notes:

1. Figures of capital stock in column (2) are derived by assuming growth rate of 25.9 percent.

2. Figures of labour force in column (3) are derived by assuming growth rate of 22.8 percent.

3. Predicted output levels derived by using equation in table 6.18.

TABLE G.5.

Results of ordinary least squares estimation of the Construction sector growth rates.

	ln α	ln β	R^2	SSR*	rate of growth
Value-Added					
1960–1967	3.0838 (27.68)**	0.0548 (2.485)	0.51	0.1227	5.6361
1968–1972	3.3566 (69.08)	0.0288 (6.566)	0.93	0.0006	2.9185
1973–1978	-1.1981 (-1.19)ns	0.3558 (5.861)	0.90	0.2579	42.725
1960–1978	2.7419 (16.07)	0.1102 (7.367)	0.76	2.1696	11.653
Capital stock					
1960–1967	2.4903 (119.8)	0.0766 (18.60)	0.98	0.0043	7.9586
1968–1972	2.2583 (24.57)	0.0993 (11.98)	0.98	0.0021	10.434
1973–1978	0.4004 (2.079)	0.2304 (19.84)	0.99	0.0094	25.908
1960–1978	2.2772 (27.81)	0.1125 (15.66)	0.94	0.4996	11.906
Labour force					
1960–1967	3.9176 (31.42)	0.0209 (0.846)ns	0.11	0.1537	2.1119
1968–1972	4.0293 (36.37)	0.0178 (1.779)	0.51	0.0030	1.7931
1973–1978	1.2777 (4.072)	0.2057 (10.87)	0.97	0.0251	22.832
1960–1978	3.7244 (37.95)	0.0551 (6.406)	0.71	0.7180	5.6694

(Continued)

Table G.5 continued

	ln α	ln β	R^2	SSR	rate of growth
Total Factor <u>Inputs</u>					
1960-1967	4.5288 (212.3)	0.0604 (14.30)	0.97	0.0045	6.2271
1968-1972	4.3379 (57.97)	0.0820 (12.15)	0.98	0.0213	8.5444
1973-1978	2.2801 (11.59)	0.2264 (19.10)	0.99	0.0098	25.411
1960-1978	4.3015 (50.55)	0.9986 (13.38)	0.91	0.5397	10.502
Kendrick's <u>Index</u>					
1960-1967	4.5251 (46.47)	-0.0026 (-0.29)^{ns}	0.14	0.0937	-0.5574
1968-1972	4.9888 (61.03)	-0.0532 (-7.22)	0.95	0.0016	-5.1831
1973-1978	2.4917 (2.734)	0.1233 (2.354)	0.58	0.2113	13.826
1960-1978	4.4105 (45.35)	0.0104 (1.216)^{ns}	0.08	0.7051	1.0427
<u>Solow's index</u>					
1960-1967	4.5264 (47.47)	-0.0053 (-0.28)^{ns}	0.01	0.0898	-0.5259
1968-1972	4.9379 (55.18)	-0.0468 (-5.80)	0.92	0.0020	-4.5764
1973-1978	2.3305 (2.069)	0.1459 (2.148)	0.54	0.3228	15.706
1960-1978	4.3694 (39.29)	0.0186 (1.911)	0.18	0.9218	1.8815

(Continued)

Table G.5 continued

	ln α	ln β	R^2	SSR	rate of growth
Capital Productivity					
1960-1967	0.5935 (4.520)	-0.0022 (-0.84)ns	0.10	0.1703	-0.2172
1968-1972	1.0984 (12.08)	-0.0705 (-8.60)	0.96	0.0259	-6.8057
1973-1978	-1.5987 (-1.76)	0.1254 (2.288)	0.57	0.2101	13.357
1960-1978	0.4646 (4.423)	-0.0023 (-0.26)ns	0.00	0.8226	-0.2251
Labour Productivity					
1960-1967	-0.8338 (-13.3)	0.0339 (2.733)	0.55	0.0389	3.4514
1968-1972	-0.6726 (-4.73)	0.0110 (0.857)ns	0.20	0.0049	1.1056
1973-1978	-2.4760 (-2.58)	0.1511 (2.594)	0.63	0.2344	16.1960
1960-1978	-0.9826 (-10.3)	0.0551 (6.557)	0.72	0.6839	5.6636
Capital/labour RATIO					
1960-1967	-1.4272 (-9.96)	0.0557 (1.96)	0.39	0.2030	5.7259
1968-1972	-1.7710 (-11.5)	0.8148 (5.890)	0.92	0.0057	8.4891
1973-1978	-0.8773 (-3.46)	0.0247 (1.616)	0.40	0.0164	2.5043
1960-1978	-1.4472 (-23.8)	0.0573 (10.78)	0.87	0.2740	5.9020

Notes
* stand for the sum squared of residuals
** t-ratios
NS not significant
Equation used as that stated in the footnotes of table B.1
Sources: calculated from data in tables G.1,G.2,6.15 and 6.16.

APPENDIX H

TABLE H.1.

Production function data for the Destribution sector, 1960-1978.

year (1)	Q output (million 1969 I.D) (2)	L labour (thousnd employd) (3)	K capital stock (million 1969 I.D) (4)
1960	89.5800	210.000	236.120
1961	106.220	219.000	260.220
1962	108.530	227.000	289.090
1963	105.570	236.000	317.540
1964	122.540	245.000	342.780
1965	151.520	254.000	365.480
1966	159.330	263.000	385.690
1967	164.800	272.000	409.790
1968	168.180	280.000	427.220
1969	174.700	288.000	443.340
1970	185.890	300.000	454.940
1971	181.500	309.000	475.840
1972	183.500	318.000	496.440
1973	187.900	316.000	518.340
1974	258.400	329.700	559.440
1975	353.820	332.300	618.620
1976	401.960	376.800	790.150
1977	432.680	399.100	978.840
1978	543.940	422.900	1087.30

Sources:

1. Output figures are from table A.1 and deflated by their implict price deflator stated in table A.2.
2. Capital stock figures are calculated from the figures in table A.5
3. Figures on number of persons employed for the years 1960-70 are from Statistical pocketbook (1970), table 10, p 27; For the years 1971-1973 are from Annual Abstract of Statistics 1973, table 208, p 358; The remanning years are from Ahmed (1978), table I.1, p 270.

TABLE H.2.

Capital productivity, labour productivity and capital/labour ratio for the Destribution sector.

year	capital productivity (Q/K)	labour productivity (Q/L)	capital/labour ratio (K/L)
1960	0.37938	0.42657	1.12438
1961	0.40819	0.48502	1.18822
1962	0.37542	0.47811	1.27352
1963	0.33246	0.44733	1.34551
1964	0.35749	0.50016	1.39910
1965	0.41458	0.59653	1.43890
1966	0.41310	0.60582	1.46650
1967	0.40216	0.60588	1.50658
1968	0.39366	0.60064	1.52579
1969	0.39405	0.60660	1.53938
1970	0.40860	0.61963	1.51647
1971	0.38143	0.58738	1.53994
1972	0.36963	0.57704	1.56113
1973	0.36250	0.59462	1.64032
1974	0.46189	0.78374	1.69682
1975	0.57195	1.06476	1.86163
1976	0.50871	1.06677	2.09700
1977	0.44203	1.08414	2.45262
1978	0.50027	1.28621	2.57106

Sources: Compiled from data in table H.1.

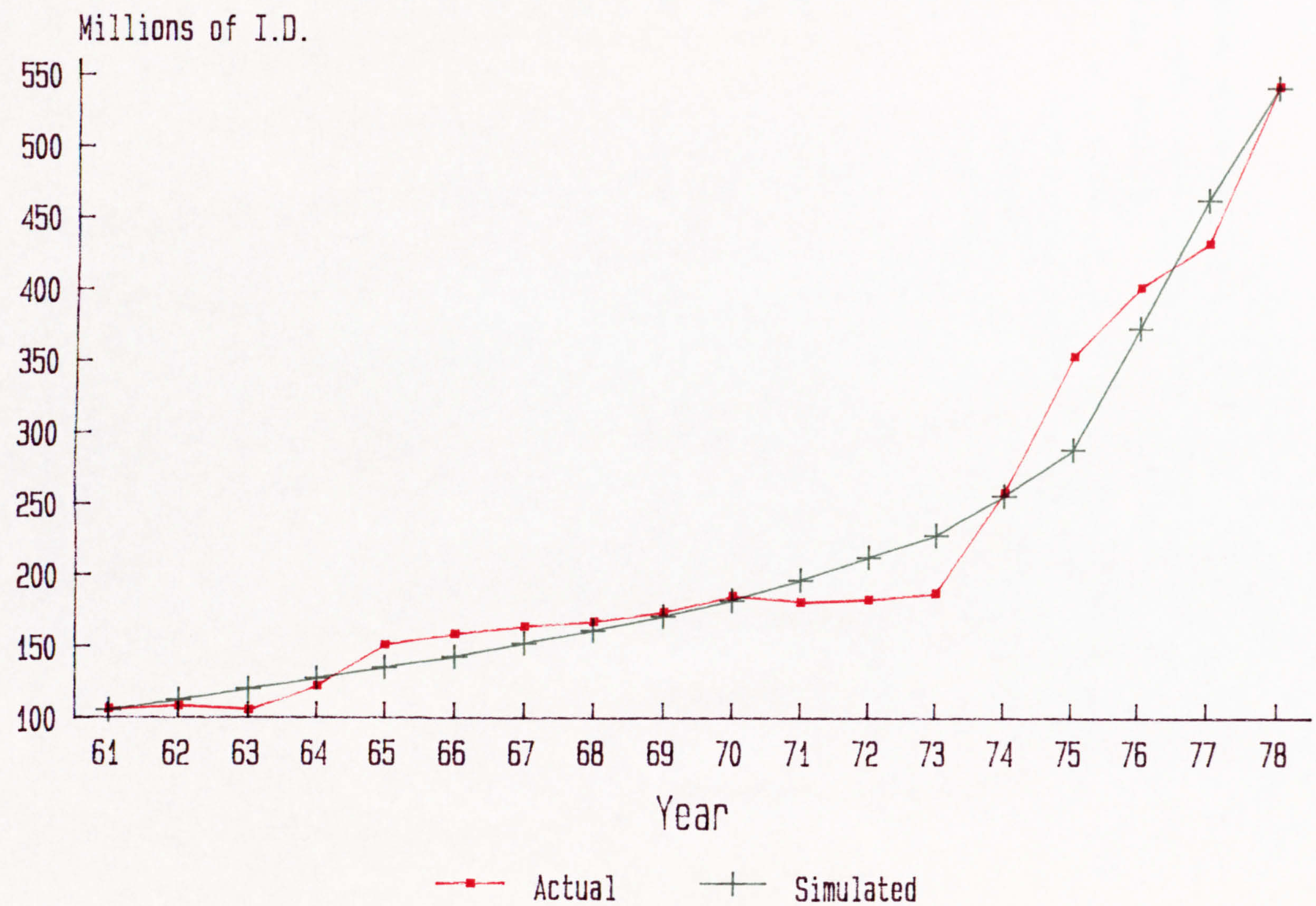
TABLE H.3.

Actual and simulated output levels for the Destribution sector, 1961-1978.

year (1)	actual output (million 1969 I.D) (2)	simulated output (million 1969 I.D) (3)
1961	106.220	105.134
1962	108.530	112.345
1963	105.570	120.019
1964	122.540	127.495
1965	151.520	135.078
1966	159.330	142.913
1967	164.800	152.524
1968	168.180	161.501
1969	174.700	171.372
1970	185.890	182.536
1971	181.500	196.734
1972	183.500	212.746
1973	187.900	228.057
1974	258.400	255.657
1975	353.820	288.103
1976	401.960	372.905
1977	432.680	463.344
1978	543.940	542.812

1. The actual outputs of column (2) are from table H.1, column (2).
2. The simulated outputs are derived from the equation in table 7.19 usinig series of capital and of labour stated in table H.1.

Figure H.1 Actual and Simulated Output Levels for the Distribution Sector, 1961-1978



Source: Table H.3

TABLE H.3.

Capital stock and labour force data for the Destribution sector used for prediction and predicted output levels, 1979-1990.

year (1)	labour force (thousnd employed) (2)	capital stock (million 1969 I.D) (3)	predicted output (million 1969 I.D) (4)
1979	450.000	1276.50	660.807
1980	478.800	1498.60	809.390
1981	509.400	1759.40	996.513
1982	542.000	2065.50	1233.28
1983	576.700	2424.90	1534.26
1984	613.600	2846.80	1918.57
1985	652.900	3342.10	2411.65
1986	694.700	3923.60	3047.19
1987	739.200	4606.30	3870.26
1988	786.500	5407.80	4941.07
1989	836.800	6348.80	6340.83
1990	890.400	7453.50	8179.68

Notes:

1. Figures of capital stock in column (2) are derived by assuming growth rate of 17.4 percent.
2. Figures of labour force in column (3) are derived by assuming growth rate of 6.35 percent.
3. Predicted output levels derived by using equation in table 6.18.

TABLE H.5.

Results of ordinary least squares estimation of the Destribution sector growth rates.

	ln α	ln β	R^2	SSR*	rate of growth
Value-Added					
1960–1967	4.4152 (84.19)**	0.0886 (8.533)	0.93	0.0272	9.2673
1968–1972	4.9515 (52.42)	0.0213 (2.496)	0.67	0.0022	2.1483
1973–1978	2.5427 (6.635)	0.1997 (8.643)	0.95	0.0374	22.101
1960–1978	4.3718 (55.66)	0.0863 (12.53)	0.90	20.460	9.0149
Capital stock					
1960–1967	5.4164 (264.8)	0.0787 (19.42)	0.98	0.0041	8.1826
1968–1972	5.7207 (270.2)	0.0371 (19.44)	0.99	0.0001	3.7804
1973–1978	3.9397 (16.70)	0.1608 (11.31)	0.97	0.0142	17.437
1960–1978	5.4164 (102.9)	0.0708 (15.34)	0.93	0.2063	7.3353
Labour force					
1960–1967	5.3761 (2524.)	0.0369 (26.75)	0.99	0.0005	3.7589
1968–1972	5.3420 (404.8)	0.0325 (27.30)	0.99	0.0000	3.3024
1973–1978	4.8717 (42.34)	0.0616 (8.879)	0.95	0.0034	6.3528
1960–1978	5.3166 (356.3)	0.0350 (26.75)	0.98	0.0166	3.5627

(Continued)

Table H.5 continued

	ln α	ln β	R^2	SSR	rate of growth
Total Factor Inputs					
1960-1967	4.5611 (356.9)	0.0631 (24.95)	0.99	0.0016	6.5161
1968-1972	4.7624 (454.6)	0.0356 (37.65)	0.99	0.0000	3.6201
1973-1978	3.3347 (16.34)	0.1334 (10.84)	0.97	0.0106	14.272
1960-1978	4.5510 (107.7)	0.0593 (16.01)	0.94	0.1332	6.1141
Kendrick's Index					
1960-1967	4.5693 (78.23)	0.0255 (2.205)	0.45	0.0337	2.5828
1968-1972	4.9043 (46.80)	-0.0143 (-1.51)	0.43	0.0027	-1.4204
1973-1978	3.9233 (6.790)	0.0663 (1.902)	0.47	0.0849	6.8511
1960-1978	4.5359 (84.35)	0.0270 (5.718)	0.66	0.2155	2.7337
Solow's index					
1960-1967	4.5663 (73.48)	0.0277 (2.251)	0.46	0.0382	2.8092
1968-1972	4.9237 (46.17)	-0.0146 (-1.52)	0.44	0.0028	-1.4519
1973-1978	3.8025 (6.241)	0.0767 (2.088)	0.52	0.0944	7.9729
1960-1978	4.5232 (76.99)	0.0306 (5.934)	0.67	0.2573	3.1050

(Continued)

Table H.6 continued

	ln α	ln β	R^2	SSR	rate of growth
Capital <u>Productivity</u>					
1960-1967	-1.0012 (-15.8)	0.0100 (0.797)	0.96	0.0394	1.0027
1968-1972	-0.7691 (-6.71)	-0.1585 (-1.54)	0.44	0.0327	-1.5727
1973-1978	-1.3970 (-2.30)	0.0389 (1.063)[ns]	0.22	0.0937	3.9668
1960-1978	-1.0447 (-17.1)	0.0155 (4.965)	0.42	0.1907	1.5649
Labour <u>Productivity</u>					
1960-1967	-0.8989 (-17.9)	0.0517 (4.964)	0.80	0.0273	5.3082
1968-1972	-0.3904 (-4.523)	-0.1123 (-1.44)	0.41	0.0018	-1.1173
1973-1978	-2.3290 (-4.85)	0.1381 (4.774)	0.85	0.0586	14.807
1960-1978	-0.9448 (-13.2)	0.0513 (8.196)	0.80	0.3797	5.2646
Capital/labour <u>Ratio</u>					
1960-1967	0.1023 (5.492)	0.0417 (11.32)	0.96	0.0034	4.2618
1968-1972	0.3787 (11.39)	0.0046 (1.540)	0.44	0.0003	0.4627
1973-1978	-0.9320 (-6.34)	0.0992 (11.19)	0.97	0.0055	10.427
1960-1978	0.0998 (2.496)	0.3578 (10.20)	0.86	0.1192	3.6428

Notes
* stand for the sum squared of residuals
** t-ratios
ns not significant
Equation used is same as that stated in the footnotes of table B.1.

Sources: calculated from data in tables H.1,H.2,6.17 and 6.18.

APPENDIX I

TABLE I.1.

Production function data for the Services sector, 1960-1978

year (1)	Q output (million 1969 I.D) (2)	L labour (thousnd employed) (3)	K capital stock (million 1969 I.D) (4)
1960	105.900	245.000	211.400
1961	119.110	250.000	252.120
1962	132.900	255.000	299.810
1963	140.430	260.000	346.950
1964	178.290	265.000	388.000
1965	197.350	270.000	436.350
1966	210.000	275.000	490.570
1967	193.750	285.000	545.230
1968	221.030	290.000	593.800
1969	242.500	295.000	643.710
1970	253.020	300.000	699.810
1971	273.600	310.000	757.900
1972	296.800	320.000	814.770
1973	323.200	330.000	878.170
1974	406.300	644.900	950.340
1975	517.900	809.100	1050.40
1976	437.500	955.100	1159.40
1977	552.500	1000.10	1269.40
1978	643.100	1047.50	1416.30

sources:
1. Output figures are from table A.1 and deflated by their implict price deflator stated in table A.2.
2. Capital stock figures are calculated from the figures in table A.5
3. Figures on number of persons employed for the period 1960 to 1970 are from Statistical pocketbook (1972), table 10,p 27; for the years from 1971-1973 are from Annual Abstract of Statistics (1973), table 208, p 358; while those for the period 1974-1978 are from Sammara (1981), table 9.4.1, p 436.

TABLE I.2.

Capital productivity, labour productivity and capital labour ratio for the Services sector.

year	capital productivity Q/K	labour productivity Q/L	capital/labour ratio K/L
1960	0.50095	0.43225	0.86286
1961	0.47243	0.47644	1.00848
1962	0.44328	0.52118	1.17573
1963	0.40476	0.54011	1.33442
1964	0.45951	0.67279	1.46415
1965	0.45227	0.73093	1.61611
1966	0.42807	0.76364	1.78389
1967	0.35535	0.67982	1.91309
1968	0.37223	0.76217	2.04759
1969	0.37672	0.82203	2.18207
1970	0.36155	0.84340	2.33270
1971	0.36099	0.88258	2.44484
1972	0.36427	0.92750	2.54616
1973	0.36804	0.97939	2.66112
1974	0.42753	0.63002	1.47362
1975	0.49305	0.64009	1.29823
1976	0.37735	0.45807	1.21390
1977	0.43524	0.55245	1.26927
1978	0.45407	0.61394	1.35208

Sources: Compiled from the data in table I.1.

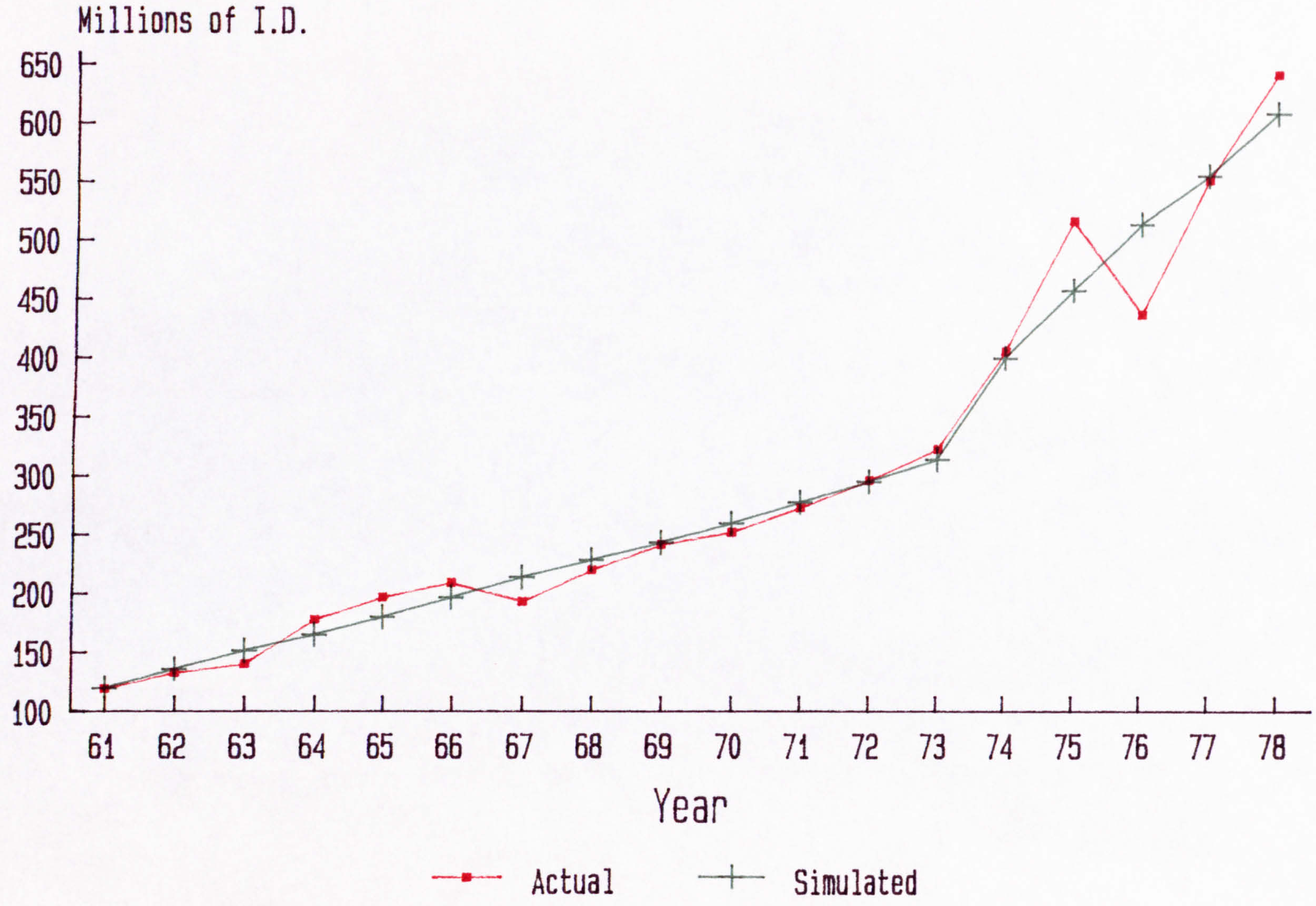
Table I.3.

Actual and simulated output levels for the Services sector,1961-1978.

year (1)	actual output (million 1969 I.D) (2)	simulated output (million 1969 I.D) (3)
1961	119.110	119.050
1962	132.900	135.572
1963	140.430	151.365
1964	178.290	164.855
1965	197.350	180.260
1966	210.000	197.041
1967	193.750	214.637
1968	221.030	229.231
1969	242.500	243.980
1970	253.020	260.193
1971	273.600	277.949
1972	296.800	295.252
1973	323.200	314.131
1974	406.300	400.283
1975	517.900	457.952
1976	437.500	514.630
1977	552.500	556.138
1978	643.100	609.284

1. The actual outputs of column (2) are from table I.1, column (2).
2. The simulated outputs are derived from the equation in table 7.19 usinig series of capital and of labour stated in table I.1.

Figure I.1 Actual and Simulated Output Levels for the Services Sector, 1961-1978



Source: Table I.3

TABLE I.4.

Capital stock and Labour force data for the Services sector used for prediction and predicted output levvels, 1979-1990.

year (1)	labour force (thousnd employed) (2)	capital stock (million 1969 I.D) (3)	predicted output (million 1969 I.D) (4)
1979	1288.40	1559.30	691.307
1980	1584.70	1716.80	784.361
1981	1949.20	1890.20	889.946
1982	2397.50	2081.10	1009.73
1983	2948.90	2291.30	1145.65
1984	3627.20	2522.70	1299.86
1985	4461.40	2777.50	1474.83
1986	5487.50	3058.00	1673.34
1987	6749.60	3366.90	1898.60
1988	8302.00	3707.00	2154.19
1989	10211.5	4081.40	2444.15
1990	12560.1	4493.60	2773.14

Notes:

1. Figures of capital stock in column (2) are derived by assuming growth rate of 10.1 percent.

2. Figures of labour force in column (3) are derived by assuming growth rate of 23.0 percent.

3. Predicted output levels derived by using equation in table 6.18.

TABLE I.5.

Results of ordinary least squares estimation of the Services sector growth rates.

	ln α	ln β	R^2	SSR*	rate of growth
Value-Added					
1960-1967	4.5901 (73.15)**	0.1011 (8.132)	0.92	0.0389	10.339
1968-1972	4.7643 (105.4)	0.0710 (17.42)	0.99	0.0123	7.3601
1973-1978	4.1726 (104.3)	0.1198 (23.87)	0.84	0.0492	12.729
1960-1978	4.6020 (104.3)	0.0923 (23.87)	0.97	0.1450	9.6740
Capital stock					
1960-1967	5.2716 (189.3)	0.1333 (24.17)	0.99	0.0077	14.261
1968-1972	5.6720 (439.0)	0.0796 (68.34)	0.99	0.0000	8.2857
1973-1978	5.4257 (172.8)	0.0959 (50.66)	0.99	0.0003	10.066
1960-1978	5.4297 (165.12)	0.0979 (33.93)	0.99	0.0806	10.282
Labour force					
1960-1967	5.4791 (1434.)	0.0205 (27.17)	0.99	0.0001	2.0756
1968-1972	5.4420 (210.9)	0.0246 (10.59)	0.97	0.0002	2.4954
1973-1978	3.1932 (3.576)	0.2073 (3.853)	0.79	0.2028	23.02
1960-1978	5.1289 (38.52)	0.0809 (6.931)	0.74	1.3209	8.4293

(Continued)

Table I.5 continued

	ln α	ln β	R^2	SSR	rate of growth
total factor inputs					
1960–1967	4.5263 (256.6)	0.1106 (31.67)	0.99	0.0031	11.696
1968–1972	4.8109 (592.2)	0.0727 (99.29)	0.99	0.0023	7.5441
1973–1978	4.2756 (37.25)	0.1132 (16.35)	0.99	0.0034	11.980
1960–1978	4.5859 (226.4)	0.0946 (53.25)	0.99	0.0306	9.9201
Kendrick's Index					
1960–1967	4.6117 (77.41)	-0.0085 $(-0.81)^{ns}$	0.10	0.0351	-0.9509
1968–1972	4.5013 (88.67)	-0.0017 $(-0.37)^{ns}$	0.04	0.0006	-0.1711
1973–1978	4.4448 (10.55)	0.0067 (0.262)	0.02	0.0451	0.6684
1960–1978	4.5640 (120.5)	-0.0022 $(-0.67)^{ns}$	0.03	0.1070	-0.2239
Solow's index					
1960–1967	4.5991 (71.13)	-0.0038 $(-0.29)^{ns}$	0.15	0.0413	-0.3820
1968–1972	4.4712 (101.7)	0.0066 (1.675)	0.48	0.0005	0.6647
1973–1978	4.8261 (10.12)	-0.0191 $(-0.66)^{ns}$	0.10	0.0579	-1.8930
1960–1978	4.6090 (123.1)	-0.0060 (-1.81)	0.16	0.1044	-0.5935

(Continued)

table i.5 continued

	ln α	ln β	R^2	SSR	rate of growth
Capital <u>Productivity</u>					
1960-1967	-0.6815 (-11.6)	-0.0323 (-2.78)	0.56	0.0340	-3.1742
1968-1972	-0.9077 (-16.9)	-0.0086 (-1.78)	0.51	0.0152	-0.8548
1973-1978	-1.2531 (-2.77)	0.0239 (0.873)	0.16	0.0518	2.4189
1960-1978	-0.8277 (-15.1)	-0.0055 (-1.15)ns	0.07	0.2234	-0.5511
Labour <u>Productivity</u>					
1960-1967	-0.8889 (-13.5)	0.0805 (6.15)	0.86	0.0432	8.3841
1968-1972	-0.6777 (-15.4)	0.0464 (11.69)	0.98	0.0005	4.7463
1973-1978	0.9793 (1.163)	-0.0875 (-1.72)	0.430	0.1802	-8.382
1960-1978	-0.5269 (-4.55)	0.0114 (1.124)ns	0.07	0.9982	1.148
Capital/labour <u>Ratio</u>					
1960-1967	-0.2074 (-6.98)	0.1128 (19.17)	0.98	0.0087	11.937
1968-1972	0.2300 (6.155)	0.0550 (16.39)	0.99	0.0004	5.6493
1973-1978	2.2324 (2.428)	-0.1114 (-2.01)	0.50	0.2151	-10.546
1960-1978	0.3008 (1.951)	0.0169 (1.252)ns	0.02	01.773	1.7085

Notes:
* stand for the sum squared of residuals
** t-ratios
NS not significant
Equation used for estimating figures of the table is as that stated in the footnotes of table B.1.