AN EMPIRICAL ANALYSIS OF THE GROWTH AND STRUCTURE OF THE LIBYAN NON-OIL PRODUCTIVE SECTORS

BY

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Declaration

This is to certify that this thesis is the result of an original investigation. The material has not been used in a submission for any other qualification, full acknowledgement has been given to all sources used.

Signature................ ....

Dedication

To my wonderful family: to my precious mother, beloved father, my lovely patient wife, and to my beautiful daughter (Libya) and my son (Ahmed).

ABSTRACT

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Keywords: *Economic growth, productive sectors, production functions, elasticity of substation, output, factor inputs, Libya.*

In this study, an attempt has been made to quantify the main determinants of long-run growth in the non-oil productive sectors (agricultural and manufacturing sectors) of Libya for the period 1970-2008 using an aggregate production function in a neo-classical framework, as well as taking account some of growth theories such as new growth theory.

Even though previous studies has shown that the Cobb-Douglas (C-D) production function is generally more suitable to deal with developing countries than the Constant Elasticity of Substitution (CES) production function, a statistical model was built in this research in order to determine the best fit function for the Libyan economy. Some statistical criteria such as values of elasticity of substitution between capital and labour, $T-test$, $F-test$ and R^2 are used to discriminate between the above two functions. Moreover, two forms of production function

with various types of technical progress with the assumptions of Constant and Variant Returns to scale were estimated, in order to determine the relative importance of factor inputs and technical progress to the growth of productive sectors.

The principal findings of the analysis of the determinants of Libyan agricultural and manufacturing sectors are as follows. Firstly, a Cobb-Douglas form with Constant Hicks neutral technical change with the assumption of Variable Returns to Scale (VRS) fits the Libyan non-oil productive sectors (agriculture and manufacturing sectors) data. This suggests the existence of unit elasticity between the factors of production. The unitary elasticity of substitution between factor inputs was an obstacle to the growth of Libyan agricultural and manufacturing sectors. Secondly, the contribution of GDP with respect to capital is found to be higher than the contribution of output with respect to labour in both agriculture and manufacturing sectors. This indicates that the change in GDP is more responsive to change in capital input than labour and technical progress in the Libyan agriculture and manufacturing sectors. Finally, technical change which accrued during the period 1970-2008 was growing at constant rates in the Libyan agricultural and manufacturing sectors, and it positively affected the output in these sectors, but its effect was relatively small, this indicated by a low elasticity of GDP with respect to technical progress.

The result of this thesis has important policy implications. It may be argued that high growth in the Libyan economy, especially in the productive sectors can be achieved by augmenting capital goods through imports, given the country's special circumstance because imported capital goods tends to embody advancement in technology that can be beneficial to production. It may also suggest that these sectors should concentrate a new product innovation, a crucial element of technical progress.

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I owe a great debt to my family; my father and my mother have given me the confidence to pursue my dreams. Their own strength and fortitude has been an inspiration.

I will not forget to say thank you to my wife who made it possible for me to pursue this dream.

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CHAPTER ONE

INTRODUCTION

1-1. Introduction:

Like other oil rich countries in the Middle East and North Africa region, the Libyan economy is characterized by a high degree of dependence on crude oil exports as the main source of foreign exchange earnings (Wilkinson, 2002). The country has, since 1970, exerted notable efforts aimed at achieving economic diversification; these efforts have led to sustained investment especially in the non-oil productive sectors, such as the manufacturing and agriculture sectors (Abdulhamid, 2005).

Since 1970 the main objective of Libyan economic development plans is to diversify the local economy and to improve the efficiency of the agriculture and manufacturing sectors, in order to find other sources of income rather than oil. Huge investment was dedicated by the government during the period 1970-2008, in order to achieve high growth. However, directing a large amount of investment to these sectors did not lead to an improvement in their performance. The question this raises is what factors have affected the performance of Libyan non-oil productive sectors. The answer is indeed not easy, since there are numerous and various forces interacting on economic growth.

In classical economic theory, growth is determined by the accumulation of capital, but it ignores the role of technical progress in achieving economic growth in the long-run. Neo-classical growth theory states that technical progress is considered to be exogenous, and is the main determinant of long-run growth, and this assumes the possibility of substitution of factor inputs (Sadeg, 1996).

However, many economists have not been satisfied with the exogenous nature of technical advancement, which is the major source of growth in the steady state in the Solow model. Among them, Schultz (1960), Arrow (1962), Becker (1964), Lucas (1988) and Romer (1990) who made technology endogenous by introducing knowledge or human capital in the production function along with physical capital. Barrow and Sala-i-Martin (1995) state that technical progress is endogenous; they assume there is no diminishing returns to capital, especially when capital input includes human capital, because there are positive externalities which affect the productivity of labour, such as education, training, and research and development (R&D).

There are many variables that can affect economic growth, among these variables are capital, labour, technical progress, and foreign direct investment, but to my knowledge, there has been no empirical study of determinants of economic growth that has included all the variables. Most empirical studies mainly depend on labour, capital and technical progress as determinants of economic growth (e.g. Solow, 1957, Sapir, 1980). Neo-classical growth theory states that to have steady positive growth and a positive capital share, the elasticity of substitution between capital and labour must be equal to one, and technical change must be labour augmenting (Uzawa, 1961 and Jones, 2004). This implies that the Cobb-Douglas production function should be adopted.

On the other hand, capital and labour shares do not show a constant trend over time in the US economy, implying that the elasticity of substitution cannot be equal to one (Jalava et al, 2005). Duffy and Papageorgin (2000) dealt with a cross-section of 82 countries and found that the elasticity of substitution is greater than one for developed countries and less than one for developing countries, implying that the Cobb-Douglas (C-D) production function form is suitable for developing countries, while the Constant Elasticity of Substitution (CES) production function form is suitable for developed countries.

This dispute has generated important question, which is whether the elasticity of substitution between capital and labour in the Libyan productive sectors is equal to one, and what form of production function best fits the production process of these sectors.

1-2. Research problem:

To implement the diversification strategy, the Libyan government has directed a large proportion of investment to its agriculture and manufacturing sectors in order to find other sources of income apart from oil (Abdulhamid, 2005). The oil sector received only 4.9% of total investment on average during the period 1970-2008, while the other main productive sectors such as agriculture and manufacturing sectors received 15.4% and 12% respectively (LSP[•], 2007) during the same period.

Theoretically, making large investments should lead to improvement in the performance of the sectors. This has not been the case in Libya. The agriculture and manufacturing sectors contribution to GDP was 4.80 % and 4.40 % respectively on average during the same period (LSP, 2007). These percentages are very low compared with their large allocations of investment, which shows the ineffectiveness of investment in these sectors. Thus, economic growth in these sectors needs to be analysed, and the factors affecting this growth also need to be determined. This raises

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[•] *LSP = Libyan Secretariat of Planning* a number of questions, which this study will try to answer. Among these questions is which form of production function is more suitable to deal with the economic process in the Libyan non-oil productive sectors?

1-3. Purposes of the study:

The main purpose of this study is to present an analytical review of the role played by production factors, i.e. capital and labour, and by technical progress in the economic growth of the Libyan non-oil productive sectors during the period 1970-2008. The Libyan economy is disaggregated into ten major sectors, namely; agriculture, forest and fishing; manufacturing; quarrying; electricity, gas and water; construction; trade, restaurants and hotels; transport, storage and transportation; finance, insurance and property; home ownership; and public services. The agriculture and manufacturing sectors have been selected as a case study in this work as examples of the productive sectors, because of the large amount of investment allocated to these areas.

The two widely-used forms of the production function, Cobb-Douglas (C-D) and Constant Elasticity of Substitution (CES) are estimated for agriculture and manufacturing sectors separately, and then for both sectors (combined to form one sector called the non-oil productive sector). Time-series of GDP, capital and labour of these sectors are used to examine different aspects of the two kinds of production function during the period 1970-2008. Statistical tests are used for selecting the best estimate, to analyse the contribution of capital and labour, and the role played by technical progress in economic growth.

This study does not limit itself to determining the contribution of factor inputs and the role of technical progress. It also attempts to measure the elasticity of substitution between capital and labour in order to define the best fit production function for the Libyan productive sector.

More practically, this thesis will answer the following research questions:

Firstly: Which form of production function is more suitable to explain the production process in the Libyan productive sectors, Cobb-Douglas or Constant Elasticity of Substitution?

Secondly: What are the factor inputs which affected the output growth of the agriculture and manufacturing sectors during the period 1970-2008?

Thirdly: What is the contribution made by technical progress to the growth of output in the Libyan productive (agricultural and manufacturing) sectors?

Fourthly: What conclusions can be drawn and, consequently, what, if any, recommendations can be made?

(1-4) Motivation and Contribution:-

From the middle of the 1980s until the present time, there have been numerous models that contrast with the neo-classical model, in which the factors that determine economic growth and the role of technical progress in the long-run are considered.

During the last three decades there have been many studies on Libyan economic development (e.g. Fayad, 2000; Abdulhamid, 2005). However, these studies have left a lot of unanswered questions about the factors contributing towards Libyan economic growth. None of the studies dealing with the Libyan economy have offered an explanation regarding the relationship between factor inputs and technical change on the one side, and economic growth on another side.

The motive and importance of this study arises from two aspects. Firstly, the absence of a systematic analysis of Libyan economic growth along the lines proposed by neo-classical growth theory has been the primary motivation of this study. Many empirical studies have analysed the relationship between capital, labour and technical progress and economic growth in many parts of the world. However, this kind of study is rare in Libya.

Secondly, this study is the first attempt to estimate and test various forms of C-D and CES production functions, in order to choose the best fit form of these functions, which can be used to analyse and determine the factors affecting economic growth in the Libyan productive sectors. The current study therefore is the first of its kind, according to the author's knowledge.

1-5. Research Methodology:

This research adopts a positivist approach and is based on quantitative data. The sources of information are bibliographical reviews, articles, periodicals, the internet, and theses regarding the research topic. It also involves published data which are obtained from government organizations such as the Ministry of Planning in Libya, the Libyan Central Bank, the UN, and the IMF. All the data is publicly accessible. The data period covers 1970 to 2008. The time-span is selected to cover all development plans that have been implemented by the current Libyan government to incorporate the impact of the structural economic changes on the productive sectors.

The growth of output, driven by the growth of factor inputs and technical progress, has been chosen as the research aim in this study because of their importance to economic development. Interrelation between changes in production factors and change in technical progress and their impact on growth of output are modelled and tested using econometric techniques. The method used in this study is consistent with previous studies in this field, especially with studies which have used both Cobb-Douglas (CD) and Constant Elasticity of Substitution (CES) implicated by neo-classical theory (e.g. Solow, 1957; Sadeg, 1996). This research follows the guidelines set up by the research ethics committee of the University of Gloucestershire as specified in the Research Ethics Handbook.

The analytical elements of this study are carried out using the framework of neo-classical theory of the production function, with two homogenous factor inputs, i.e. capital and labour. The function must satisfy the conditions of monitonicity and concavity. The first condition, monitonicity, means that the marginal productivity of any factor input should be positive, while concavity means that the second partial derivative is less than or equal to zero.

Both non-linear and linear techniques are used to estimate the two forms of production function, i.e. Constant Elasticity of Substitution (CES) and Cobb-Douglas (C-D), in order to answer the first and second research questions. Measuring the value of the elasticity of substitution between capital and labour is achieved through dealing with the estimated parameters of the CES production function. The Ordinary Least

Square (OLS) is adopted in estimating the production functions. There are several reasons for choosing the OLS. Firstly, the parameters obtained by OLS have some optimal properties, such as best, linearity and unbiased. Secondly, the computational procedure of OLS is fairly simple compared with other economics techniques, and the data requirements are not excessive. Thirdly, the OLS method has been used in a wide range of economic relationships with fairly satisfactory results (Koutsoyiannis, 1993).

There are two ways to measure the contribution made by technical progress. These ways are: firstly, the indirect or non-parametric approach implying the methods of Solow (1957), Kendrick (1961) and Wan (1995). The second way is the direct approach or the parametric approach, implying a constant and variant Hicks neutral technical progress method. The direct approach will be adopted in this study because it is the mostly common used according to previous studies (Sadeg, 1996).

1-6. Data Collection and Issues:

The data used in this study are the time series of Gross Domestic Product (GDP), net capital stock (K) and labour, in terms of the number of people employed, (L). The period 1970-2008 is covered by the study. This time series is chosen because it includes the results of all the development plans of the Libyan government to show their impact on the productive sectors.

Some of these series, especially for net capital stock, are not readily available; therefore it is necessary to construct them. This is not easy task for a developing country such as Libya, as the data are inadequate and incomplete. A series of net capital stock input was constructed using a perpetual inventory method which assumes that net capital stock in period (t) is equal to the net capital stock in the period $(t-1)$ plus new investment value in the period (for more details see equation 4-1). To construct the capital stock for the period of study starting from 1970, the depreciation value of 1969 is required; therefore, this value was obtained from the study of Abohobiel (1990). The main caveats of the data set are the inaccuracy of published data, as there is more than one source such as the Central Bank of Libya, General Authority for Information, as well as international sources such as Food and Agriculture Organisation (FAO) and the International Monetary Fund (IMF). But unfortunately, there was no consensus in the data for gross national product, the number of workers, and capital in these different data sources.

Many political and structural factors generated instability in the Libyan economic growth. Some of these factors have been taken in account by assuming dummy variables. These factors were particularly prevalent in the periods 1973-1974, which was the time of the Arab-Israel war; 1979-1980, which was the time of the Iranian crises, 1982, which was the time of the world recession; 1992-2002, which was the time of the economic blockade on Libya; and finally the period 2002-2008 which saw some major structural and management changes in the country. The last period also saw huge increases in the value of GDP; this increase was due to the surge in oil prices and also due to an increase in the quota of oil exports at that time.

In addition to the above factors, one dummy variable takes into account structural changes in the agricultural sector during the period 1993 to 1996. This structural change was due to the application of a three-year programme, which aimed at staging the liquidation of obligations on development projects and classifying them into essential and non-essential projects. Essential projects had to be implemented and non-essential ones were either cancelled or converted to private sector activity. This followed the application of law 9/1992 which resulted in a significant decrease in actual expenditures of the development budget in the agricultural sector, which in turn resulted in a decrease in domestic agricultural output over the above mentioned period.

Another problem facing the study was the lack of some necessary important data, such as the value of the actual expenditure on the productive sectors (investment in the productive sector) especially in the end of study period. However, those problems are not a sufficient reason for ignoring these variables in the estimation process.

The year 1980 has been chosen as the base year in the time series of Gross Domestic Product and capital stock for several reasons, including: it is economically stable, and the year 1980 was characterized by a low rate of inflation. This year is also in the middle of the period covered by the study. The sources of the data are: the Libyan Ministry of Planning, the Libyan Ministry of the Economy; Libyan Central Bank; publications of the League of Arab States; publications of the IMF; and the Arab Organization for Agricultural Development.

1-7. The plan of the study:

This study has been divided into eight chapters as follows:

Chapter one

This chapter is an introductory one giving an overview of this piece of research, summarizing its aims and describing the research problem, the process of data gathering and the methods used to deal with these data. Types of data and their source are also outlined.

Chapter two

This chapter represents a brief summary of the Libyan economy for the period 1970-2008. It provides the required background information on the performance of the Libyan economy in the period under consideration. This chapter also shows the development of the economic variants in the agriculture and manufacturing sectors. Some economic indicators of the Libyan productive (agriculture and manufacturing) sectors, such as their contribution towards Gross Domestic Product (GDP), capital formation and the labour force in these sectors are analysed to evaluate their role in the Libyan economy and their contribution to economic activity. In addition, oil revenue and public expenditure and their impact on the growth of output in the Libyan productive sectors are also described.

Chapter three

This chapter is devoted to theoretical reviews; in particular, the positive theory of long-run economic growth is reviewed. In this chapter, four main models following the classical model are discussed: the Harrod-Domar growth model, the neo-classical growth model, endogenous growth model, and the Club of Rome (or the classical theory of economic growth revisited). This chapter also defines the essence of the production function and its historical development. It also reviews the most important types of production function in economic literature.

Chapter four

This chapter reviews some applied studies related to the two types of production function (Cobb-Douglas and Constant Elasticity of Substitution production function), which have been carried out in different parts of the world. Special reference is made to some specific studies which focus on measuring the elasticity of substitution between capital and labour, in order to compare between the two kinds of function. This chapter also discusses the measurement of production (Q), capital (K), and labour (L) used in the existing literature. The different methods used for measuring technical change are described.

Chapter five

This chapter is concerned with the methods and procedures which are adopted in this study. An econometric model for the Libyan economy is constructed in this chapter. This chapter also provides the growth accounting framework implicit in neo-classical growth theory.

Chapter six

This chapter contains applications of the stationary test and co-integration test as a first step in the estimation process. The C-D and CES production functions in their different forms are estimated for the agriculture and manufacturing sectors separately. This chapter also contains the measurement of average and marginal product with regard to labour and capital. The results of the estimation are outlined.

Chapter seven

The production functions (C-D and CES) of the Libyan productive sector (in this study a combination of the agricultural and manufacturing sectors) are estimated in this chapter on the basis of the annual data of the period stretching from 1970-2008. All the necessary statistical and empirical tests were carried out to determine the average and marginal product of all the factors involved in the production process.

Model validation, including model simulation using all necessary statistical tests, is presented.

Chapter eight

This chapter summarizes all the empirical results reached in this study and makes recommendations.

This study contains two appendices including: appendix (A) for general basic data (data set of the model) and appendix (B) giving co-integration test results.

CHAPTER TWO

An Overview of the Libyan Economy

2-1. Introduction:

This chapter focuses on the role of two productive sectors (agriculture and manufacturing sectors) in the Libyan economy through:

- The importance of the relative shares of these sectors in the Gross Domestic Product (GDP) of Libya.
- The importance of the two sectors in their absorption of labour force and creation of employment opportunities.

The purpose of this chapter is to give an overview of the Libyan economy and its composition during the study period, especially terms of the productive sectors. All of these are discussed in the next section, 2-2. Section 2-3 outlines the importance of productive sectors in Libya and it contains sections 2-3-1 and 2-3-2 that describe the sectors that have been selected for this study (agriculture and manufacturing sectors), in order to show their importance to the Libyan economy. Economic indicators of the agricultural and manufacturing sectors are discussed in section 2-4. Finally, section 2-5 contains a summary of this chapter.

2-2. The structure of the Libyan economy:

Libya is located in the north of the African continent on the southern coast of the Mediterranean. It lies between longitude 9° and 25.9° east, and 18° and 33° north and longitude 18.45° south. It is bordered to north by the Mediterranean Sea. Its coast is 1900 km in length. It is one of the longest coastlines on the littoral of the Mediterranean.

Libya is bordered by Niger and Chad to the south, and to the east by Egypt and Sudan, and to the west by Tunisia and Algeria. The estimated total area of the country is about 1.77 million square kilometres, of which more than 90% are desert (Alidrissi, et al, 1996). The population of Libya according to the latest population census of 2006 is about 5.657 million (LBC*, 2008). According to altitude above sea level, climate, soil quality, rainfall and vegetation, Libya is divided into five major ecological zones, namely:

1) Coastal plain area
2) Northern mountains
3) Southerly mountains
4) Semi-desert areas
5) Desert areas

Climate in Libya is a mixture of Mediterranean and desert climate, the impact of the Mediterranean climate becomes less so further from the coast, where the desert climate prevails. Geographical variation is reflected in the differences in temperature, whereby the bulk of the country is located in warm climate areas. In coastal areas, the climate is moderate with high humidity, with wind blowing through the summer and autumn seasons. The average annual temperature is between 23-25C^0 in coastal zones, 25-28C^0 in semi-desert areas, and more than 30C^0 in desert areas. The average rainfall in coastal areas is between 150-400 mm / year and it may reach 600 mm / year for the Green Mountain area which is in the east of the country. There is less rainfall further south from the coastal zone.

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[*] LBC= Central Bank of Libya

In 1949 the United Nations voted to confer complete independence on Libya, which it attained on 24th December 1951 as the kingdom of Libya. Initially, the kingdom was federated with three provinces of equal weight and with their own regional centres of government. Later on, in 1963 the federal constitution of the country was amended by law No. 1 of that year and a unitary government established itself in Tripoli (Othman and Karlberg, 2007). Many political changes occurred after the 1st September 1969; Libya became a republican regime, followed by economic and social changes. The most important of these changes was the declaration of the Libyan Jamahiriya on 2nd March 1977. Jamahiriya, according to the Green Book by Gaddafi, means a self-governing people taking decisions through the people's congresses.

The system of government is public and calls for the exercise of power through the people's congresses, which are open to all Libyans over 18 years old. People's Congresses elect members who represent their local area. These members sit on the General People's Congress, which is the highest legislative body in the country. The General People's Congress has the authority to consider general policy plans and their implementation. However, it is subject to the advice of the General People's Committee and the supervision of the general secretary and General Secretariat, which make the final decisions. The political environment in Libya is very important and has an influential role in economic activities, this is clear from the dominance of the public sector of economic activity in Libya, and the relative paucity of the role of system is laid out in Green Book.

The public sector in Libya dominated the management and conduct of economic activity from the beginning of the revolution until 1977. The public sector played the dominant role in economic activity due to the government's ownership of oil resources and control over their production. In 1977, with the emergence of the Third World Theory advocated by Gaddafi, slogans such as "partners not wage-workers" became institutionalized. The maxim was a starting point for a socialist system calling for the participation of all members of the community in sharing the benefits of the economy. In March 1981 all private retail licenses were officially suspended, although this law was never fully implemented. However, by the end of the same decade, Gaddafi had changed course and was publicly proclaiming the benefits of a rapid expansion in private enterprise (Alidrissi, et al, 1996). On this basis, small firms were established, which were named Tasharukeyat.

The trend towards privatization began with the passing of a number of laws that enabled private enterprise to enter a range of economic activities. Law No. 9, concerning the conduct of economic activities, was issued in 1992, and as a result thousand of companies were established, and the "Tasharukeya" exercise established various new economic activities (Othman and Karlberg, 2007). The privatization process in Libya was given the task of "expanding the base of ownership". Libya started to make up for the years of state control by freeing up its highly centralized economy. The government officially declared itself to be unnecessary for economic activity, and the process of reducing the role of the public sector and developing the private sector began. The government was keen to develop and diversify the economy in order to reduce its dependence on non-renewable oil resources, and to export a wider range of products.

Economically, Libya used to be one of the poorest countries in the world; its per capita income in 1950 did not exceed 50 dollars per year (Boalghemh and Aelkeziri, 1995). The Libyan economy before the discovery of oil depended entirely on agriculture, it was the economic pillar of the country at that time with more than 70% of the population working in the sector (Alarbah, 1996), and there was no industry except some simple traditional industries that did not have a significant role in the national economy.

This situation continued until the discovery of oil in 1958. The relative prosperity created by an increase of the money spent by companies on exploration and prospecting in the country brought a great change in national income. The rate of oil production developed quickly, which enabled the country to export more. The estimated daily production rate was about 18,000 barrels a day in 1961, which increased to 1.2 million barrels a day in 1965 (Boalghemh and Aelkeziri, 1995).

However, the oil production declined after 1970, this was because of application of regulations to preserve the oil wealth from depletion, in order to have greater returns in the long term and also because high prices of oil in 1973 which led some countries including Libya to reduce their consumption of oil and move to other resources (Boalghemh and Aelkeziri, 1995).

Theoretically, improvement of oil revenues should lead to an improvement in the performance of other productive sectors. This was not the case in Libya (Otman and Karlberg, 2007). The contribution of agriculture to GDP fluctuated from 13.5% in

1962* to 2.6% in 1970 and 2.2% in 1980 and then 5.9% in 1990 and 1.9% in 2008. Table 2-1 shows the evolution of the contribution of each sector to total output of the country during the period 1970-2008.

Table 2-1

Share of economic sectors in GDP at constant prices of 1980 during the period 1970-2008

Values in million L.D. and at constant price.

Sector/ year	1970		1980		1990		1995		2000		2008	
	Q	% of GDP	Q	% of GDP	Q	% of GDP	Q	% of GDP	Q	% of GDP	Q	%in GDP
Agriculture	86.6	2.6	236.4	2.2	250.9	5.9	196.7	8.7	222.2	8.1	313.3	1.9
Manufacturing	58.9	1.7	210.4	2.0	237.8	5.6	156.6	6.9	150.1	5.5	735.9	4.5
General Services(includes education and health)	402.1	11.9	940.8	9.0	596.5	13.9	364.6	16.2	411.4	15.1		
Other services	20.9	0.6	47.4	0.4	90.5	2.1	73.7	3.3	62.4	2.3		
Oil	2128	63.1	6525.7	61.8	1685.9	39.3	712.3	31.7	1027.9	37.8	11491.8	70
Other sectors	675.9	20.1	2593.5	24.6	1115.1	26	745.3	33.1	845.1	31.1		
GDP	3372.5	100	10553.8	100	4286.3	100	2249.2	100	2719.2	100	16392	100

Q is value of production Source: The Libyan General Secretariat of Planning (1997), Economic and Social Indicators. Table (6), (7) and (9), PP 46-48.

- The Libyan Central Bank. Annual report number 41. Financial year 1997. Table (14) 37.
- The Libyan Central Bank. Economic Bulletin in 2008.

In addition, the contribution of the manufacturing sector to GDP fluctuated from 2.6% in 1965* to 1.7 % in 1970 and from 5.6 % in 1990 to 4.5 % in 2008.

From 1970 the Libyan government developed plans aimed at improving the economic situation of the country, and specifically diversifying of income sources, and a reduced reliance on oil. Food security was one of the moral imperatives for Libyan planners. Huge efforts were expended to achieve this goal (Othman and Karlberg, 2007).

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* For the figures in the period 1962-1969 see a table (7) and (9) in the Source of The Libyan General Secretariat of Planning(1997), Economic and Social Indicators.

The government directed most investment to the productive sectors, such as the agriculture and industrial sectors, in order to achieve the following objectives[1] :

1) To enable the growth rate in GDP to exceed the growth rate in population, and then to increase the growth rate of per capita income.
2) To diversify sources of national income and to reduce dependence on oil as a major source of income.
3) To provide employment opportunities for domestic workers.
4) To increase the efficiency of public services and basic industries, and to encourage the economic and social development process.

2-3. The importance of the productive sectors to Libya:

The importance of the productive sectors to Libya derives from the interest of development planners and the country as a whole in those sectors. These sectors have received extraordinary attention since the early 1970s up to this moment, represented by the allocation of large amounts of investments in development plans and budgets. After the export of oil began in 1961 Libya, gradually increased its production, and oil revenue became the main source of financing the country's economic activities. The government has always sought to find an alternative source of revenue, in order to diversify its income, and reduce the reliance of the national economy on importing most of its goods from abroad.

Since 1961, the government has carried out three economic and social development plans, namely: the three-year plan of economic and social development

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[1] Secretariat of Information and Culture, 'Libya's revolution in 30 years, shifts of political, economic and social', p. 253.

1973-1975; and the plans of economic and social transformation 1976-1980, and 1981-1985. Through these plans the government directed a significant proportion of investment into the productive sectors, especially agriculture and manufacturing. When the country allocated its annual development budgets, the lion's share of investments over this period were always to these sectors.

However, observers of the evolution of the Libyan economy have noted that the contribution of the productive sectors to GDP, especially the agriculture and manufacturing sectors, is still modest and not commensurate with the enormous development in oil revenues and the investment spent on these sectors (GSP, 1997). This has raised some questions about the factors affecting the growth of productive sectors, as well as the economic policies that need to be followed to increase the production in these sectors.

2-3-1. The importance of agriculture to Libyan economic structure:

The importance of agriculture historically comes from it being one of the most important economic activities in any community, whether in primitive or advanced societies. Agricultural activity is the first and most important source of human food, as well as the raw materials necessary for many different industries.

In addition, work in agriculture provides employment opportunities for younger generations. Economists have always been interested in advancing agricultural techniques in order to raise production levels, and to improve the quality of crops produced.

Libya like most countries needs to develop its agricultural sector, in order to diversify its source of economic income. This reduces the country's dependence on one sector, which is the oil sector.

The Libyan government during the transformation plan 1973-1975 aimed to achieve self-sufficiency in the materials necessary to meet local food production needs; in this plan LD555 million were allocated to the agricultural sector, which was 25% of the total development budget at that time, amounting to LD2203.

The economic and social transformation plan during the years 1976-1980 allocated LD 1703.2 million to the agriculture sector. The plan aimed to achieve a growth rate equal to 15.1% of real output. However, this was not the case as the sector achieved a growth rate of only 4%. The plan aimed to increase the contribution of agriculture to GDP from 2.1% to 2.6%. However, this was not achieved either, as the contribution of agriculture to GDP fell to 1.9% (GSP, 1996)•

The economic and social transformation plan for the years 1981-1985 aimed to increase local agricultural production in order to reduce the amount of food imports. The agriculture sector received LD1494.1 million, a sum equal to 16% of total investment expenditure for that plan. The economic plan of 1991-1995 was especially targeted at the agriculture sector. The agriculture sector received LD480.2 million, and LD10 million was allocated to a project that used river water to reclaim arable land.

• GSP= General Secretariat of Planning

In the period 1970-2008 agriculture was a priority sector for economic planners. It received about 17% of total investment expenditure. As a result, agriculture output at constant prices increased from LD86.6 million in 1970 to LD217.5 in 1985 because of huge allocation directed to these sectors, and it increased from LD217.1 million in 1999 to LD313.3 million in 2008. The contribution of agriculture to GDP moved from 2.6% in 1970 to 11% in 1998, which was its peak, and fall again to 1.9 % in 2008. In spite of the considerable investment directed to this sector, its contribution to the GDP was low over the period of study, never exceeding 11%. This reduction in the relative importance of agriculture to gross domestic product (GDP) was due to the fluctuations in oil output value during the same period.

Table 2-2 and figure 2-1 show the contribution of agriculture to GDP during the period 1970-2008. Figure 2-2 shows the changing rate of agricultural output during the same period. Agriculture and manufacturing contribute significantly less than the oil and service sectors to overall GDP, in terms of their contribution to gross domestic product (see table 2-1). The public service and trade sectors rank second and third respectively, after the oil sector, since the public service sector is the main employer of labour in the economy. The manufacturing and agriculture sectors rank fourth and fifth respectively, while the construction sector ranks in sixth place.

Table 2-2

The contribution of agriculture to GDP and its annual growth rate during the period 1970-2008

Value in million L.D at constant prices

year	Agricultural GDP	GDP value	Agricultural to GDP %	Change rate of agricultural GDP
1970	86.6	3372.5	2.6	-
1971	67.2	3231.2	2.1	-22
1972	94.2	3786.2	2.5	40
1973	135.7	4937.8	2.7	44
1974	138.2	8110.5	1.7	2
1975	167.5	7422.8	2.3	21
1976	184.6	8829.8	2.1	10
1977	147.5	9201.1	1.6	-20
1978	178.2	8023.5	2.2	21
1979	166.7	9029.7	1.9	-6
1980	236.4	10553.8	2.2	42
1981	264.1	8493.1	3.1	12
1982	246.5	7706.9	3.2	-7
1983	236.5	6644.6	3.6	-4
1984	224.1	5416.2	4.1	-5
1985	217.5	4991.8	4.4	-3
1986	236.7	4283.5	5.5	8
1987	242.5	3544.6	6.8	2
1988	242.0	3536.9	6.8	-0.2
1989	248.3	4060.4	6.1	3
1990	251.0	4286.3	5.9	1
1991	252.3	4073.2	6.2	0.5
1992	254.9	3734.6	6.8	1
1993	239.0	3080.8	7.8	-6
1994	218.1	2547.6	8.6	-9
1995	196.7	2249.2	8.7	-10
1996	188.7	2164.6	8.7	-4
1997	185.4	2019.4	9.2	-2
1998	237.1	2144.7	11	27
1999	217.1	2107.1	10.4	-8
2000	222.2	2719.2	8.2	2
2001	235.5	3059.1	7.6	6
2002	253.1	4861.9	5.2	7
2003	263.6	7157.2	4.3	4
2004	282.2	9432.4	3.5	7
2005	298.9	12779	2.8	6
2006	316.6	15554.9	2.0	6
2007	332.5	15577.7	2.1	5
2008	313.3	16392	1.9	-5.8
period	*Average of annual growth rate*			
1970-1995	*5%*			
1996-2008	*3.9%*			

Source: calculated from tables 1 and 8 in appendices

Figure (2-1): Agricultural GDP compared with the GDP value during the period 1970-2008

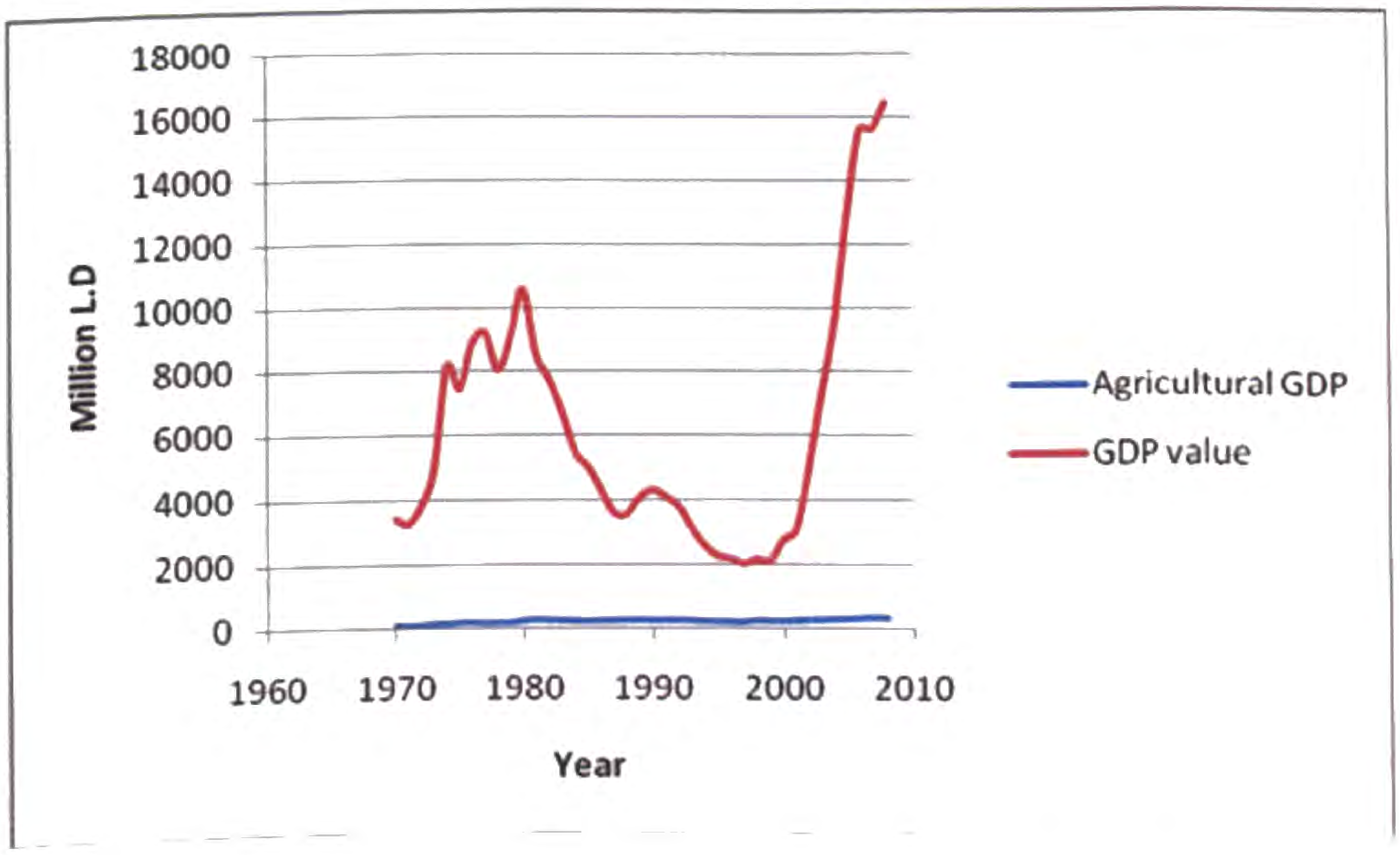
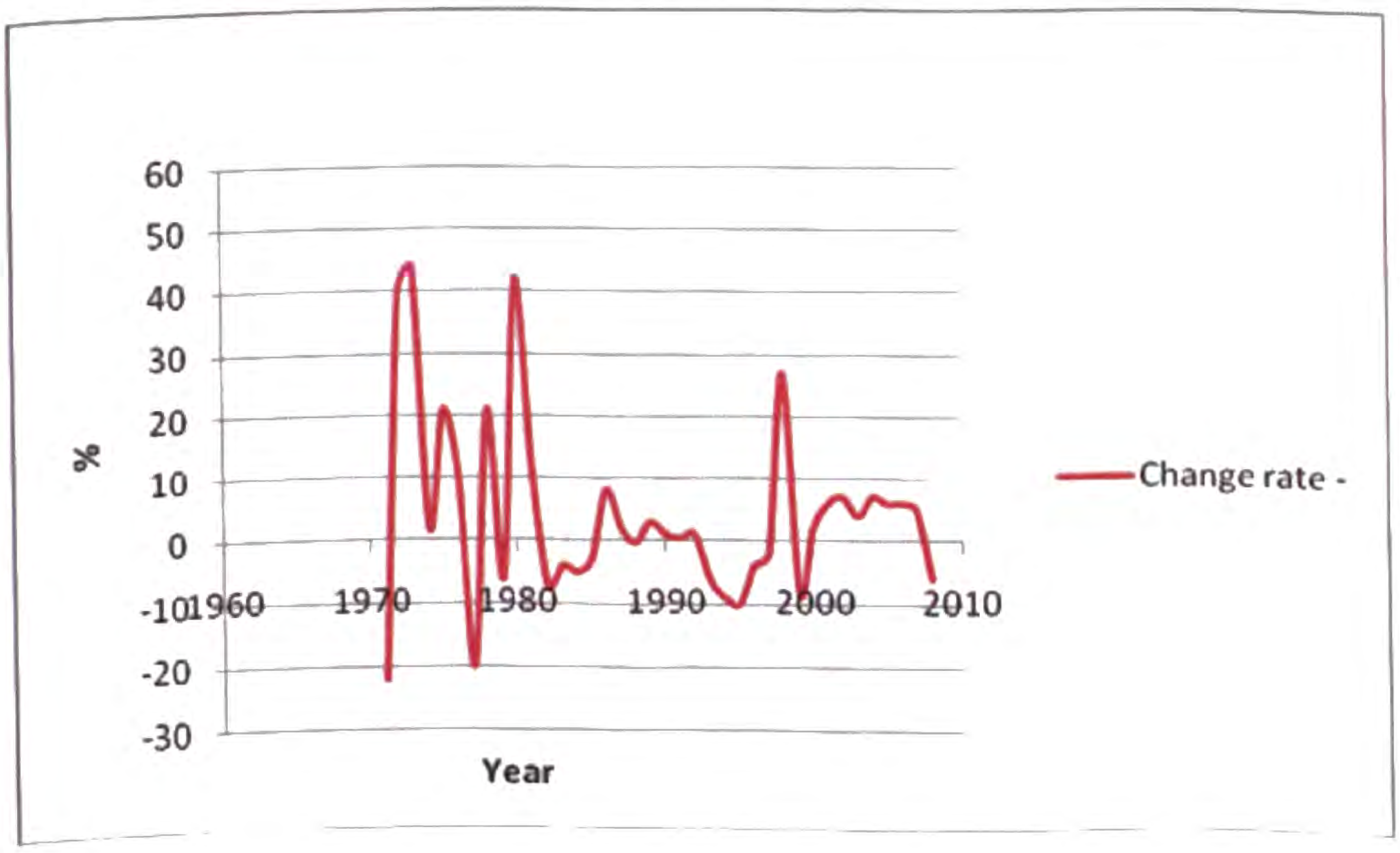


Figure (2-2): The changing rate of agricultural GDP during the period 1970-2008



2-3-2. Definition of manufacturing industries in Libya:

Manufacturing industries are industries based on agricultural materials or raw materials, whether metallic minerals or non-metallic minerals. The most important characteristic of manufacturing industries to the Libyan economy is the possibility they provide to participate in foreign trade. The manufacturing sector in Libya is divided into two main industries, namely heavy and light industry. According to the classification of products, light industries are usually those which produce consumer products, and heavy industries are those which produce investment goods (Al arbah, 1996).

The structure of manufacturing industries in Libya is divided into six groups, which are:

1. The food industry including mills, feed, dairy, vegetables, canned fruits, bread, sweets, soft drinks, and tobacco.
2. The manufacture of yarn and fabric, leather, furniture and paper, including clothing, textiles, shoes, bags, home and office furniture, paper products, bandages and cotton wool.
3. Chemical industries including batteries, tyres, soap, cleaning materials, various plastic products, paints, sponges and various industrial and medical gases.
4. The cement industry and construction materials, including cement and lime, plastic pipes and tiles, glass and ceramics.
5. The main metallurgic industries including iron and steel products such as rolls and iron bars.

6. Engineering and electrical industries including tractors, trailers, buses, iron and aluminium tubes, refrigerators and stoves, bicycles, electric wire and equipment, video recording equipment and audio-visual technology, and computers .

Economic development policy in Libya started at the beginning of the seventies, and aimed to give greater importance to the manufacturing sector to play its role in terms of reducing reliance on oil as a source of income. It also aimed to reduce reliance on the importation of goods from abroad. To achieve this aim, Libya increased in spending on the manufacturing sector, which was reflected in a number of economic projects. Increased attention was to give the manufacturing sector through the allocations during the period 1970-2008.

Despite the huge investment dedicated to the manufacturing sector, the main aim was not achieved, which was to find alternative sources to generate foreign currency. Furthermore, despite the construction of an appropriate industrial base, sales of industrial production were mostly confined to the local market (Al arbah, 1996).

2-3-2-1. Evolution of the contribution of the manufacturing industries GDP:

Table 2-3 and Figure 2-3 show the evolution of the real value of industrial GDP and its percentage of GDP. Illustrated by the figures are the following observations:-

1- Real value of industrial output at constant prices of 1980 increased from LD58.9 million in 1970 to LD735.9 million in 2008, approximating to a twelve-fold increase. Despite this increase in real output of the manufacturing sector, which seems high, its contribution to GDP during the same period did not exceed 7.7%.

2- The disproportionate percentage of the contribution of manufacturing to GDP, despite huge investment in the sector, can be traced to the decline in average labour productivity, which can be attributed to several factors, including problems resulting from the lack of spare parts and raw materials, in addition to a lack of manpower with technical skills.

3- The relative importance of the manufacturing sector to GDP increased from 1.7% in 1970, reaching its highest value in 1993 at 7.7%, and then dropping to around 4.5% in 2008. This increase in the relative importance of the manufacturing sector cannot be attributed to an increase in industrial production, but is due to a reduction in the relative importance of the oil sector, especially in the period 1982-2001, which can be attributed to the important changes in the international oil market and the consequent negative effects on the income of Petroleum Exporting Countries.

4- There were some fluctuations in the figures for manufacturing output. Its value increased during the period 1970-1990; this reflects the country's interest in this sector in that time. But the value of manufacturing output was decreased during the period of economic blockades, this was because the reduction in oil revenues resulting a decline in manufacturing`s share to GDP. The value of manufacturing output increased during the period 2001-2008 and this is due to several causes, including rising oil prices and an increase in the quota of the OPEC oil export terminal (LCB, 2010).

Figure 2-4 shows the changing rate in real output in the manufacturing sector during the period 1970 – 2008.

Table 2-3
Manufacturing GDP and its share of GDP during the period 1970-2008

Value in Million L.D at constant prices (1980=100)

year	*Industrial GDP*	*GDP value*	*Industrial GDP of GDP %*	*Annual growth rate of manufacturing GDP*	*Annual growth rate of the real GDP*
1970	58.9	3372.5	1.7	-	-
1971	49.9	3231.2	1.5	-15	-4
1972	69.1	3786.2	1.8	38	17
1973	99.1	4937.8	2	43	30
1974	117.5	8110.5	1.5	18	64
1975	132.3	7422.8	1.8	12	-8
1976	167.8	8829.8	1.9	26	19
1977	204.4	9201.1	2.2	22	4
1978	217.1	8023.5	2.7	6	-13
1979	220.7	9029.7	2.4	2	12
1980	210.4	10553.8	2.0	-5	16
1981	243.6	8493.1	2.9	16	-19
1982	229.3	7706.9	3.0	-6	-9
1983	256.9	6644.6	3.9	12	-13
1984	250.6	5416.2	4.6	-2	-18
1985	268.1	4991.8	5.4	7	-8
1986	221.3	4283.5	5.2	-17	-14
1987	197.2	3544.6	5.6	-10	-17
1988	227.1	3536.9	6.4	15	-0.2
1989	232.8	4060.4	5.7	3	14
1990	237.8	4286.3	5.6	2	5
1991	221.4	4073.2	5.4	-7	-5
1992	224.5	3734.6	6.0	1	-8
1993	236.0	3080.8	7.7	5	-17
1994	159.1	2547.6	6.3	-32	-17
1995	156.6	2249.2	7.0	-2	-11
1996	123.4	2164.6	5.7	-21	-4
1997	119.8	2019.4	5.9	-3	-7
1998	132.5	2144.7	6.2	10	6
1999	129.2	2107.1	6.1	-2	-2
2000	150.1	2719.2	5.5	16	29
2001	148.5	3059.1	4.8	-1.0	12
2002	152.5	4861.9	3.1	2.6	59
2003	146.4	7157.2	2.0	-4	47
2004	149.2	9432.4	1.5	1.9	32
2005	153.6	12779.0	1.2	2.9	35
2006	155.4	15554.9	0.9	1.1	21
2007	142.2	15577.7	0.9	-8.4	0.1
2008	127.5	16392.0	0.7	-10	5
period	***Average of annual growth rate***				
1970-1985	***11.6%***				
1986-2008	***6.1%***				

Source: this table was calculated from table A(2) in the appendices.

Figure 2-3: Real manufacturing GDP compared with real GDP value

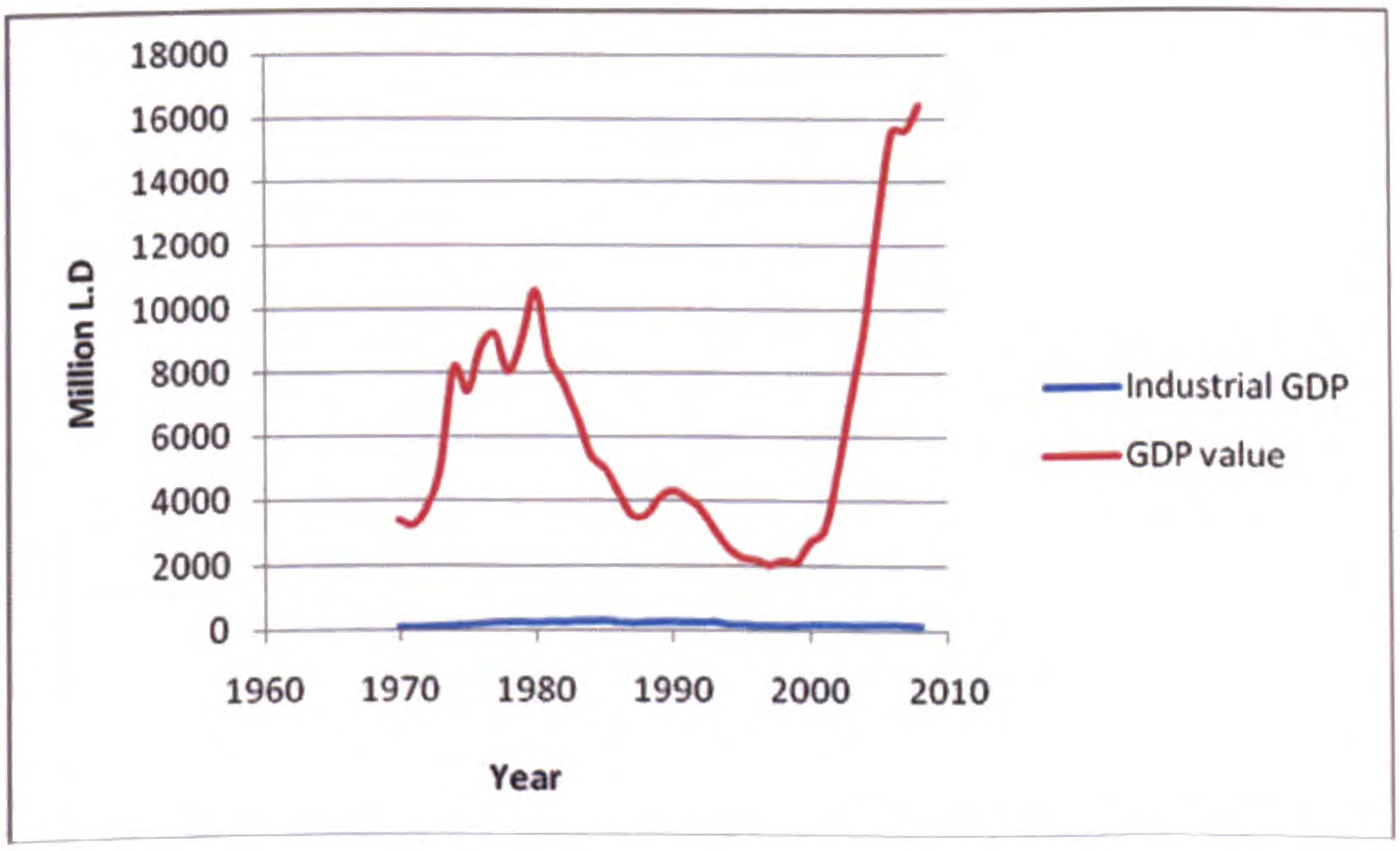
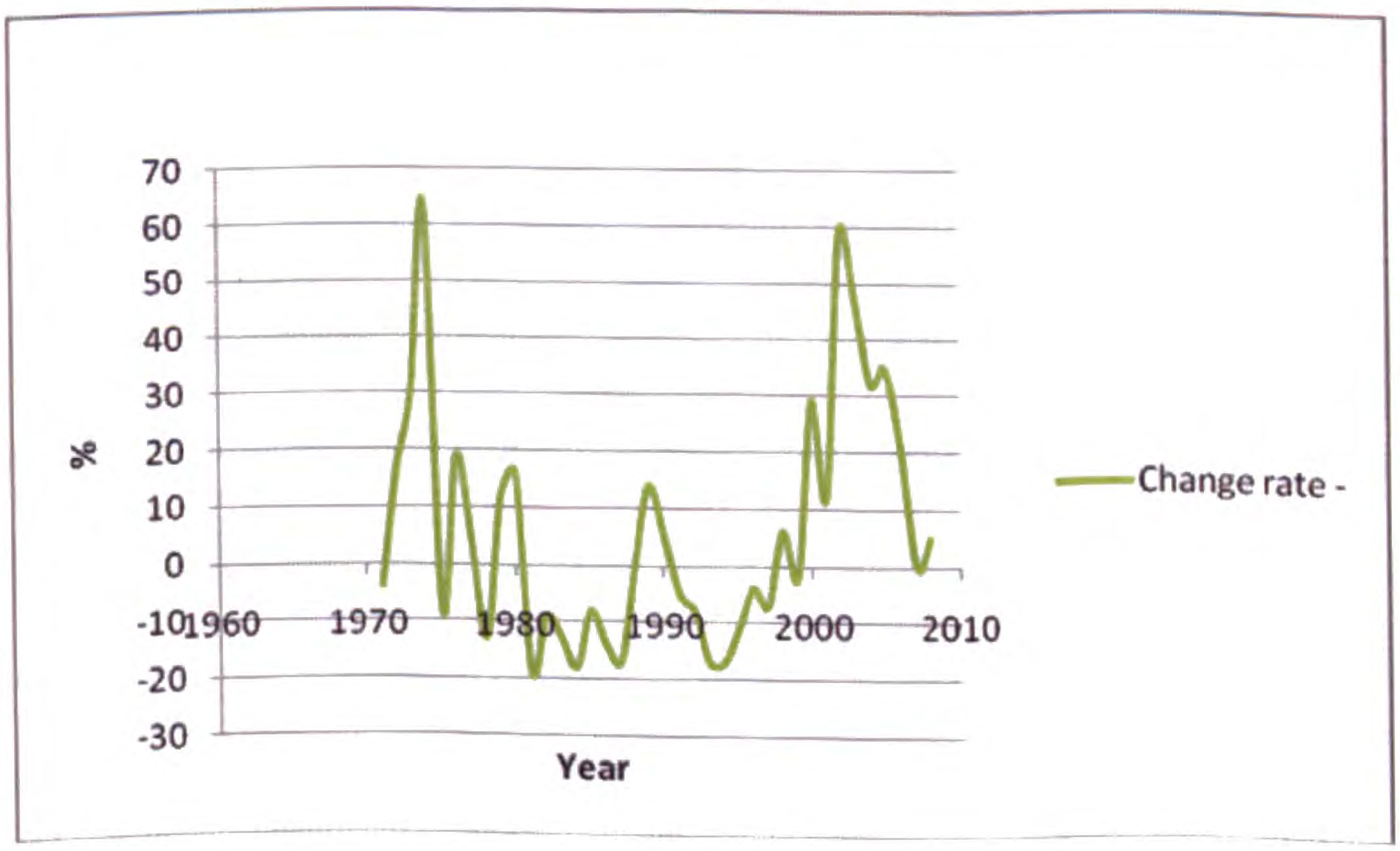


Figure 2-4: The changing rate of manufacturing GDP during the period 1970-2008



2-4. Economic indicators of the agriculture and manufacturing sectors in the Libyan economy:

The purpose of this section is to provide an overview of the Libyan economy, in order to carry out analysis of economic growth in the Libyan productive sectors over the period covered.

The growth of Gross Domestic Product (GDP) is discussed in section 2-4-1. Section 2-4-2 describes real capital formation and its role in the Libyan economy. The population structure is discussed in section 2-4-3 the impact of oil revenues on the Libyan economy and the impact of public expenditure on the productive sectors are provided in sections 2-4-4 and 2-4-5 respectively. Finally, a summary of this chapter is outlined in section 2-5.

2-4-1. Growth of Gross Domestic product (GDP):

The annual growth performance data of the agriculture, manufacturing and oil sectors are presented in tables 2-2, 2-3 and table A5 in the appendices, respectively. The annual growth rates of the GDP for the whole economy were calculated at constant prices. From table 2-3 it can be seen that the highest annual growth rate of GDP amounted 64% in 1974 and the lowest amounted -19% in 1981. The explicit fluctuation in the growth rate of GDP is due to changes in international oil markets. The oil price increased sharply during 1973-1974 and 1979-1980, as a result of the Arab-Israel war and the Iranian crises respectively. Negative growth of GDP during the eighties and nineties period was due to the international oil price crisis in the eighties, as well as being due to some political and economic problems faced by the country, such as the economic blockade.

It can be seen from table 2-2 that the growth rate agricultural GDP as a proportion of GDP for the whole economy during the period 1970-1995 was much higher than in the period 1996-2008. This indicates that Libya gave greater attention to the productive sectors in the first period which called the development plan periods, than the second one.

The growth rate of GDP in the manufacturing sector during the period 1970-1985 was much higher than in the period 1986-2008. However, the growth rate of oil GDP in the same period was 4.7%, and 12.5% in the period 1986-2008, and this was higher than the growth rates of the agriculture and industry sectors, (see table A5 in appendices). The increase in the growth rate of oil GDP during the period 2002-2008 was due to two reasons: Firstly, an increase in international oil prices; secondly, an increase in the share of Libya's oil production, which increased from 1.2 million barrels a day to 1.8 million barrels in 2008 (LCB, 2010).

2-4-2. Capital formation and its role in the Libyan economy:

In every nation constant capital formation plays a vital role in economic development and achieving growth in the economy and productivity. Capital formation also influences economic growth even with a limited supply of labour. It is not only important as aggregate level, but cross all different sectors.

Table 2-4 shows the evolution of the real fixed capital formation of the agriculture and manufacturing sectors and their percentage of the gross fixed capital formation of the whole economy. From the table can be seen that:-

1) Total real fixed capital formation in agriculture and manufacturing industries amounted to LD4883.4 and LD4411.4 million respectively at 1980 prices. Over the period 1970-2005, these investments accounted for about 12.5% and 12% respectively of the real total fixed capital formation in the economy, which is equal to about LD39123.6 million.

2) The data in Table 2-4 refer to increasing proportion of the real fixed capital formation in the agriculture and manufacturing sectors to the total fixed capital formation during the period 1970-2005. The table also refers to the increasing proportion of fixed capital formation in the agriculture and manufacturing sectors compared with the proportion of fixed capital formation in the oil sector during the same period, which amounted on average to 8% of gross fixed capital formation. This also indicates that Libya gave a high level of attention to the productive sectors. The average of annual growth rate of capital fixed formation over the period 1970-1995 in the agriculture sector was equal to 28.8%, while over the period 1996-2005 it was equal to 9.3%, and in the manufacturing sector it was equal to 21.6% during the period 1970-1985, while it was equal to 14.5% during the period 1986-2005.

3) Clear fluctuation was also noted from the table 2-4 in annual growth rates of fixed capital formation for the whole economy, this is due to several reasons, including:-

- Some political and economic crises suffered by the Libyan economy, such as the economic blockade during the period 1992-2002, which had a negative impact on the whole economy and in particular on the productive sectors, which depended entirely on the import of investment and semi-manufactured goods from abroad.

- The decrease in oil prices during the eighties also had a negative impact on total expenditure, especially on investment expenditure.

Table 2-4

The capital fixed formation in Agriculture, Manufacturing and Oil sectors and their share of total capital fixed formation during the period 1970-2008.

Value in million LDs *At constant prices (1980=100)*

year	*CFF in Agriculture sector*	*% in TCFF*	*Growth rate of CFF in agriculture*	*CFF in Manufacturing sector*	*% in TCFF*	*Growth rate of CFF in Manufacturing*	*CFF in Oil sector*	*% in TCFF*	*Growth rate of CFF in oil*	*TCFF*	*Growth rate of CFF in agriculture*
1970	30.4	5	-	24.6	4	-	243.5	38	-	635.3	-
1971	68.4	12	125	62.1	10	152	58.0	10	-76	586.4	-7.6
1972	81.9	9	49	118.6	12.5	90	63.7	7	10	942.8	60.7
1973	179.6	12	119	170.0	12	43	73.1	5	15	1439.4	52.6
1974	329.3	16	83	272.0	13	60	47.2	2	-35	2092.7	45.3
1975	302.8	14	-8	245.5	11	-10	52.7	2	12	2130.7	1.8
1976	316.5	14	4.5	317.0	14	29	44.8	2	-15	2270.2	6.5
1977	308.8	14	-2	269.8	12	-15	74.4	3	66	2243.1	-1.1
1978	317.5	14	3	238.2	11	-12	144.7	6	94	2236.5	-0.2
1979	278.1	12	-12	320.4	14	34	103.8	4	-28	2322.2	3.8
1980	336.4	12	21	429.1	15	34	171.7	6	65	2756.8	18.7
1981	338.1	13	0.5	481.5	19	12	150.2	6	-12	2567.9	-6.8
1982	204.9	8.5	-39	300.3	12	-37	127.4	5	-15	2391.3	-6.8
1983	162.6	8	-20	311.3	16	4	256.0	13	100	1970.6	-17.5
1984	132.1	9	-18	290.1	19	-7	119.2	8	-53	1476.5	-25.0
1985	76.6	8	-42	136.7	14	-52	92.7	9	-22	990.5	-32.9
1986	50.6	6	-33	109.8	13	-20	88.1	10	-5	846.7	-14.5
1987	42.2	7.5	-16	79.6	14	-27	86.2	15	-2	560.1	-33.8
1988	41.1	7	-2.6	90.8	15	14	83.8	14	-2	600.2	7.1
1989	63.7	10	54	46.5	7	-48	104.7	16	25	653.2	8.8
1990	90.5	15	42	22.8	4	-50	125.1	21	19	590.0	-9.6
1991	14.0	3	-84	17.5	4	-23	92.4	19	-26	481.1	-18.4
1992	34.4	8	145	27.3	7	56	98.9	24	7	407.7	-15.2
1993	175.8	34	411	41.3	8	51	136.9	27	38	506.9	24.3
1994	108.0	25	-38	45.2	10	9	96.2	22	-29	427.4	-15.6
1995	84.7	32	-21	34.2	13	-24	32.5	12	-66	262.3	-38.6
1996	76.6	26	-9	53.0	18	55	19.2	6	-40	288.0	9.7
1997	95.0	38	24	12.1	5	-77	18.6	7	-3	246.5	-14.4
1998	58.8	25	-38	22.3	9	84	39.8	17	113	237.5	-3.6
1999	38.5	16	-34	14.0	6	-37	44.6	19	12	230.0	-3.15
2000	78.5	22	103	6.2	2	-55	30.9	9	-30	352.0	53.0
2001	81.0	22	3	6.4	2	3	33.8	9	9	365.2	3.7
2002	93.5	14	15	32.7	5	410	65.7	10	94	671.6	83.8
2003	57.9	9	-38	28.2	4	-13	73.8	11	12	638.1	-4.9
2004	49.5	6	-14	34.5	4	22	90.6	11	22	781.9	22.5
2005	85.1	9	72	33.3	4	-3	115.4	12	27	924.4	18.2
2006	217.1			111.9							
2007	222.3			113.6							
2008	223.1			113							

sectors	*period*	*Average of annual growth rate*
Agriculture	*1970-1995*	*28.8%*
	1996-2005	*9.3%*
Industry	*1970-1985*	*21.6%*
	1986-2005	*14.5%*
Oil	*1970-1985*	*7%*
	1986-2005	*8.75%*

Source: this table was calculated by the research from table 7 in appendices.
CFF= Capital Fixed Formation.
TCFF= Total Capital Fixed Formation.

2-4-3. The population structure in Libya:

The results of the censuses conducted during the period covered by this study refer to the fact that the population increased from 1.963 million people in 1970 to 3.642 million people in the year 1984, and reached 4.799 million in 1995, and 5.6577 million people in 2006 (LBC*, 2008). Thus, the net annual growth rate of population achieved during the period 1970-1984 was 4.21%, which then decreased in the period 1984-1995, to reach about 2.86%. Further data show that the net annual growth rate of the population continued to decline, to become about 1.83% during the period 1995-2006.

The reasons for the decline in the population growth rate can be attributed to the following main factors (Othman and Karlberg, 2007)

- Increase in the average age of first marriage within the period 1970-1984 from 25 to 32 years for males, and from 19 to 23 for females.
- Decrease of fertility level, as indicated by average children per single Libyan women of child-bearing age (15-49 years).
- Increase in the rate of Libyan women participating in economic and social activities.
- Increase in the rate of females aged between 15 and 24 years participating in education and also advances in education for the population in general.

In the period 1970-1983 the Libyan population grew very fast, this was because of an increase of non-Libyan nationals, who increased by 18% on average during the above period, while the Libyan population increased by 4 % on average in the same period. The strong increase in the non-Libyan population was because of the

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* LBC= the Libyan Central Bank.

discovery and export of oil in the early 1970s (Othman and Karlberg, 2007). However, for the period 1984-1995 the growth rate of the non-Libyan population decreased to -0.1% until Libya opened its borders to Arabs and Africans by cancellation of the requirement for entry visas. The result was that the size of the non-Libyan population doubled again.

Table 2-5

Distribution of population (Libyan & non-Libyan) and their growth rates during the period 1970-2008.

Numbers in thousands

year	*Size of population (in thousands of people)*			*Growth rate of population %*			*Percentage of total population %*		
	Libyan	*Non-Libyan*	*Total*	*Libyan*	*Non-Libyan*	*Total*	*Libyan*	*Non-Libyan*	*total*
1970	1879.0	84.0	1963.0	4.2	29.2	5.0	95.7	4.3	100
1971	1935.1	109.0	2044.1	3.0	29.8	4.1	94.7	5.3	100
1972	1992.9	137.3	2130.2	3.0	26.0	4.2	93.6	6.4	100
1973	2052.4	196.9	2249.3	3.0	43.4	5.6	91.2	8.8	100
1974	2128.8	283.3	2422.1	4.2	43.9	7.7	88.5	11.7	100
1975	2228.9	366.6	2595.5	4.2	29.4	7.2	85.9	14.1	100
1976	2322.8	433.6	2756.4	4.2	18.3	6.2	84.3	15.7	100
1977	2420.6	439.5	2860.1	4.2	1.4	3.8	84.6	15.4	100
1978	2522.6	416.5	2939.1	4.2	-5.2	2.8	85.8	14.2	100
1979	2628.8	428.0	3056.8	4.2	2.8	4.0	86.0	14.0	100
1980	2739.6	441.2	3180.8	4.2	3.1	4.1	86.1	13.9	100
1981	2855.0	580.0	3435.0	3.9	31.5	8.0	83.1	16.9	100
1982	2975.2	680.0	3655.2	4.2	17.2	6.4	81.4	18.6	100
1983	3100.5	760.0	3860.5	4.2	11.8	5.6	80.3	19.7	100
1984	3231.1	411.5	3642.6	4.2	-45.9	-5.6	88.7	11.3	100
1985	3322.8	295.0	3617.8	2.8	-28.3	-0.7	91.8	8.2	100
1986	3416.9	245.1	3662.0	2.8	-17.0	1.2	93.3	6.7	100
1987	3513.8	423.2	3937.0	2.8	72.7	7.5	89.3	10.7	100
1988	3613.4	436.6	4050.0	2.8	3.2	2.9	89.2	10.8	100
1989	3715.9	599.6	4315.5	2.8	37.3	6.6	86.1	13.9	100
1990	3821.3	703.7	4525.0	2.8	17.4	4.9	84.4	15.5	100
1991	3929.6	796.4	4726.0	2.8	13.2	4.4	83.1	16.8	100
1992	4041.1	907.9	4949.0	2.8	14.0	4.7	81.7	18.3	100
1993	4155.7	886.8	5042.5	2.8	-2.3	1.9	82.4	17.6	100
1994	4273.5	600.0	4873.5	2.8	-32.3	3.4	87.7	12.3	100
1995	4389.7	409.3	4799.0	2.7	-31.8	-1.5	91.5	8.5	100
1996	4519.4	500.1	5019.5	3.0	22.2	4.6	90.0	10.0	100
1997	4647.5	700.0	5347.5	2.8	39.9	6.5	87.0	13.0	100
1998	4768.8	405.4	5174.2	2.6	-42.1	-3.2	92.2	7.8	100
1999	4895.1	405.4	5300.5	2.8	4.0	2.9	92.0	8.0	100
2000	5021.4	405.4	5426.8	4.5	4.0	4.5	92.0	8.0	100
2001									100
2002									100
2003									100
2004									100
2005									100
2006	5298.2	359.5	5657.7						100
2007									100
2008									100
The annual growth rate during the period1970-1984					***4.21%***				
The annual growth rate during the period 1985-1995					***2.86%***				
The annual growth rate during the period 1996-2006					***1.83%***				

2-4-3-1. Age and gender structure of the Libyan population:

The results of the census of 2006 in comparison with the previous one and showed that simple changes had occurred in the sex distribution of the Libyan population during this period, and that whereas in 1984 Libyan males accounted for about 51.12% of the total population, this percentage had fallen to 50.82% in 1995, and further declined to 50.73% in 2006 (LHC, 2006).

This indicator shows that the qualitative composition of the population in Libya has tended towards stability in the recent period. In terms of the age structure of the Libyan population, the results of the population census in 2006 referred to the fact that among the total Libyan population, a total of 5.6577 million people, 1.724 million people were under the age of 15 years, amounting to about 30.5% of the total population. This percentage had reached about 49% in 1984, and it declined to about 39% in 1995.

The results of the 2006 census indicated that this percentage is continuing to decline. Table 2-6 shows the relative distribution of the age structure of the Libyan population.

Table 2-6

Distribution of Libyan population, 1995 and 2006

population	Ages	Number in population			Percentage of total population		
		Male	Female	Total	Male	Female	Total
1995	Below 15	870342	843921	1714263	39.01	39.09	39.05
	Above 15	1360737	1314739	2675476	60.99	60.91	60.95
	Total	2231079	2158660	4389739	100.0	100.0	100.0
2006	Below 15	847098	877615	1724713	31.43	30.00	30.48
	Above 15	1848047	2085231	3933278	68.57	70.00	69.52
	Total	2695145	2962846	5657791	100.0	100.0	100.0

Source: Libyan Higher Committee for statistics and census, 2006.

2-4-3-2. The size of manpower, labour force and their contribution to economic activity rates:

The distribution of population among different age groups in any country is very important for the development of this country. If the dependency ratio* decreases in the community, this indicates that the labour force in this country would be sufficient to develop this country, while if it increases, the labour force is not sufficient to develop the country, and this leads to a heavier burden of expenditure on non-productive services such as education, health, utilities, which weakens saving capabilities and capital formation (International Labour Office, 2006).

The definition of the labour force in Libya is the economically active population divided into three sectors; all individuals engaged in work, job-seekers who had work previously and first time job seekers. The Libyan population resident in Libya is divided between those who are aged up to 15 years and those over 15 years. According to these concepts the size of the Libyan population who were economically active in 2006 amounted to about 1,635.780 people, which is 42% of the total Libyan population aged 15 years and over. Namely the rate of manpower contribution to economic activity was about 45% (LHC, 2006).

On the other hand, the number of Libyans already engaged in work in 2006 was 1,328,286, who amounted to about 81.2% of the total of the economically active population. The unemployment rate in Libya, according to the latest census in 2006 was estimated at 18.8% (LHC, 2006). Table 2-7 shows the numerical distribution of the Libyan population aged 15 years and over by distribution and type of manpower.

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* people under the age of 15 years and who are over the age of 64 years

Table 2-7

Comparison of 1995 and 2006 census: Libyan population above 15 years working and non-working.

Population	Category	Number of population			Percentage of total population		
		Male	Female	Total	Male	Female	Total
1995	Economic working	895187	205769	1100956	65.79	15.65	41.15
	Non-economic working	465550	1108970	1574520	34.21	84.35	58.85
	Total	1360737	1314739	2675476	100.0	100.0	100.0
2006	Economic working	1117612	518171	1635783	60.48	29.59	42.0
	Non-economic working	1064444	1233060	2297504	39.52	70.41	58.0
	Total	1848047	2085231	3933287	100.0	100.0	100.0

Source: Libyan Higher Committee for statistics and census, 2006.

The table also shows that the dependency rate of every Libyan economically active is estimated at about 3-1, this means that each economically active person supports 3 members of the population including himself or herself.

It should be noted that this rate was 3.99 persons according to the census of 1995, and 4.74 per person in the 1984 census; thus, the dependency ratio has declined from about five people in 1984 to three people in 2006 (LHC, 2006).

2-4-3-3. Employment structure and development:

Demand for labour increased at a faster rate than the local labour supply in Libya, this was because of an increase in investment expenditure, which began with the discovery of oil, causing a shortage in the labour force necessary for an economic development process, and thus necessitating the use of non-Libyan labour (Othman and Karlberg, 2007).

Table 2-8 and Figure 2-5 show the evolution of the labour force in Libya during the period 1970-2008. Some observations can be made from the table:

- Total labour force, Libyan and non-Libyan increased from 433.5 thousand workers in 1970 to 1797.4 thousand workers in 2008, at an annual rate of 3.2%
- The number of workers in the agriculture sector increased from 126,000 workers in 1970 to 239,100 workers in 2000 at an annual compound growth rate of 2.3 % and reached 125,800 workers in 2006.
- Total employment in the manufacturing sector increased from 204,000 workers in 1970 to 169,600 workers in 2000 with an annual compound growth rate of 7.3 %, and this figure reached 136,300 workers in 2006.

The number of workers had started to decline, and by the end of the study period in both sectors, they amounted to about 51 and 127 thousand workers in the agriculture and manufacturing sectors respectively. This was because workers preferred to join the general service activity and oil sectors, which paid much more money than the productive sectors.

- Despite the significant contribution of the oil sector to GDP, the proportion of the number of workers in the agriculture and manufacturing sectors to total employment is more than in the oil sector. Employment as a proportion of total employment in the agriculture and industry sectors on average is equal to 16.7% and 8% respectively, while it is equal to 2.5% in the oil sector, and this indicates that the oil sector in Libya is capital-intensive.

- By looking at table 2-8 and figure 2-6, 2-7 and 2-8 it can be seen that the change rates of the labour force used in the agriculture, manufacturing and the oil sectors during the period 1983-1997 took a negative and decreased direction, this was because of the implementation of some decisions issued by the General People's Committee in Libya in 1984, to reduce the size of the labour force. This was due to the relative decline in the income generated by crude oil in that period, and also because of the actions that were taken to reduce the development budget and restrictions on conversion of foreign currency abroad.

Table 2-8

Labour force in agriculture, industry sectors and their percentage to total labour in Libya during the period 1970-2008.

The numbers in thousands.

Years	Agricultural sector			Manufacturing sector			Oil sector			Number of workers		
	Number of workers	% to total workforce	increase rate of labour %	Number of workers	% to total workforce	increase rate of labour %	Number of workers	% to total workforce	increase rate of labour %	Libyan	Non-Libyan	Total
1970	126	29.1	-	20.4	4.7	-	10.0	2.3	-	383.5	50.0	433.5
1971	127	27.7	0.8	21.4	4.6	4.9	10.0	2.2	-	395.0	64.0	459.0
1972	127.7	26.2	0.6	22.9	4.7	7.0	10.0	2.1	-	407.0	81.0	488.0
1973	129.0	24.0	1.0	25.9	4.8	13.1	10.2	1.9	2.0	419.7	118.4	538.1
1974	131.4	21.6	1.9	29.3	4.8	13.1	10.4	1.7	2.0	437.4	169.8	607.2
1975	133.4	19.7	1.5	32.9	4.8	12.3	10.7	1.6	2.9	454.1	223.3	677.4
1976	141.2	19.3	5.8	37.4	5.1	13.7	11	1.5	2.8	470.1	262.6	732.7
1977	144.9	19	2.6	41.5	5.5	11.0	11.3	1.5	2.7	498.8	266.0	764.8
1978	147.9	19.1	2.1	47.4	6.1	14.2	11.7	1.5	3.5	520.4	252.3	772.7
1979	150.1	19	1.5	52.8	6.7	11.4	11.7	1.5	-	529.0	260.0	789.0
1980	153.4	18.9	2.2	58	7.1	9.8	13.7	1.7	17.1	532.8	280.0	812.8
1981	162.4	17.2	5.9	64	6.8	10.3	13.8	1.5	0.7	560.2	386.4	946.6
1982	167.5	15.5	3.1	73.7	6.8	15.2	14.0	1.3	1.4	588.4	495.3	1083.7
1983	173	14.7	3.3	80.5	6.8	9.2	13.8	1.2	-1.4	617.4	562.1	1179.5
1984	185.5	20.0	7.2	72.0	7.8	-10.6	13.0	1.4	-5.8	664.0	263.1	927.1
1985	177.0	19.8	-4.6	75.0	8.4	4.2	13.5	1.5	3.8	700.0	194.2	894.2
1986	178.5	19.7	0.8	77.0	8.5	2.7	13.6	1.5	0.7	738.7	166.0	904.7
1987	180	19.2	0.6	79.0	8.4	2.6	13.7	1.5	-2.1	792.5	144.3	936.8
1988	186.9	19.4	3.8	85.8	8.9	8.6	15.4	1.6	12.4	820.3	142.8	963.1
1989	191.6	19.1	2.5	92.2	9.3	7.5	15.7	1.6	1.9	840.7	154.7	995.4
1990	188.9	18.5	-1.4	99.4	9.8	7.8	16.9	1.7	7.6	879.4	139.2	1018.6
1991	189.6	18.7	0.4	101.1	10.0	1.7	17.5	1.7	3.6	927.2	85.3	1012.5
1992	195.7	18.7	3.7	105.4	10.1	4.3	18.1	1.7	3.4	967.9	76.1	1044.0
1993	201.2	18.1	2.8	112.6	10.1	6.8	18.5	1.6	2.2	962.1	151.6	1113.6
1994	206.0	18.2	2.4	120.5	10.5	7.0	19.2	1.7	3.8	992.9	156.1	1149.0
1995	212.7	17.8	3.3	124.5	10.5	3.3	19.8	1.7	3.1	1025.2	161.0	1186.2
1996	219.5	17.8	3.2	128.5	10.5	3.2	20.5	1.7	3.5	1057.5	166.5	1224.0
1997	219.2	17.5	-0.1	147.8	11.8	15.0	21.6	1.7	5.4	1085.7	169.4	1255.1
1998	225.1	17.0	2.7	156.8	11.8	6.1	37.5	2.8	73.6	1151.6	172.1	1323.7
1999	232.0	16.7	3.1	163.7	11.8	4.4	38.7	2.8	3.2	1203.9	179.9	1383.8
2000	239.1	16.5	3.0	169.6	11.7	3.6	39.9	2.8	3.1			1445
2001	113.2	7.8	-52.0	115.8	8.0	-31.7	40.0	2.8	0.3			1448.4
2002	107.2	7.2	-5.30	118.7	7.9	2.5	43.9	2.9	9.7			1492.6
2003	102.1	6.6	-4.7	121.6	7.9	2.4	45.7	2.9	4.1			1535.0
2004	109.2	6.9	6.9	126.2	7.9	3.8	48.9	3.1	7.0			1588.8
2005	117.0	7.0	7.1	131.2	7.9	3.9	50.4	3.0	3.1			1665.2
2006	125.8	7.3	7.5	136.3	7.9	3.9	53.4	3.1	5.9			1727.2
2007	67.9	3.9	-46.0	128.5	7.3	-5.7	58.5	3.3	9.5			1749.7
2008	51.00	2.8	-24.9	127.2	7.1	-1.0	61.6	3.4	5.3			1797.4
Average		16.7	-1.2		7.9	5.3		2.2	5.7			

Sources: General Authority for Information and Documentation; Council of General Planning (the Ministry of Planning), Central Bank of Libya, IMF, World Bank; Privatization and Investment Board.

- Results show that the majority of workers were employed in the activity of the Libyan general service, such as public administration and education. The total number of workers in education amounted to about 30.82%, while Libyans engaged in public administration amounted to about 25.81% of the total employed, thus, more than 56% of Libyan workers were working in public service activity. This had a negative impact on the contribution of the productive sectors to GDP, whereby the number of workers engaged in the agriculture and industry sectors made up on average about 16.7% and 7.9% respectively of the total labour force (Othman and Karlberg, 2007).

Figure 2-5

The Libyan workforce in the agricultural, manufacturing and oil sectors compared with total employees (labour) during the period 1970-2008.

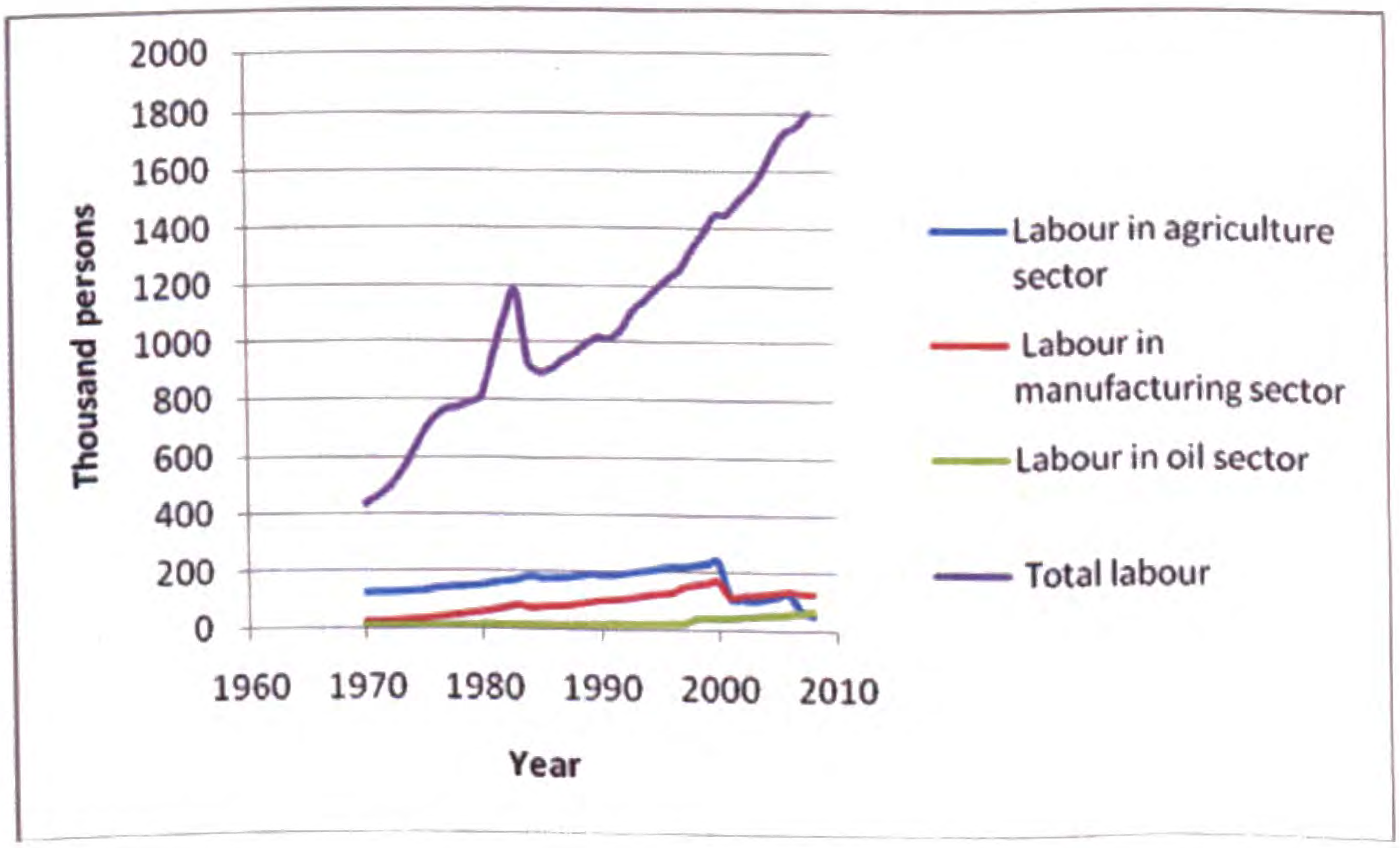


Figure 2-6

Change rate of labour used in agriculture sector

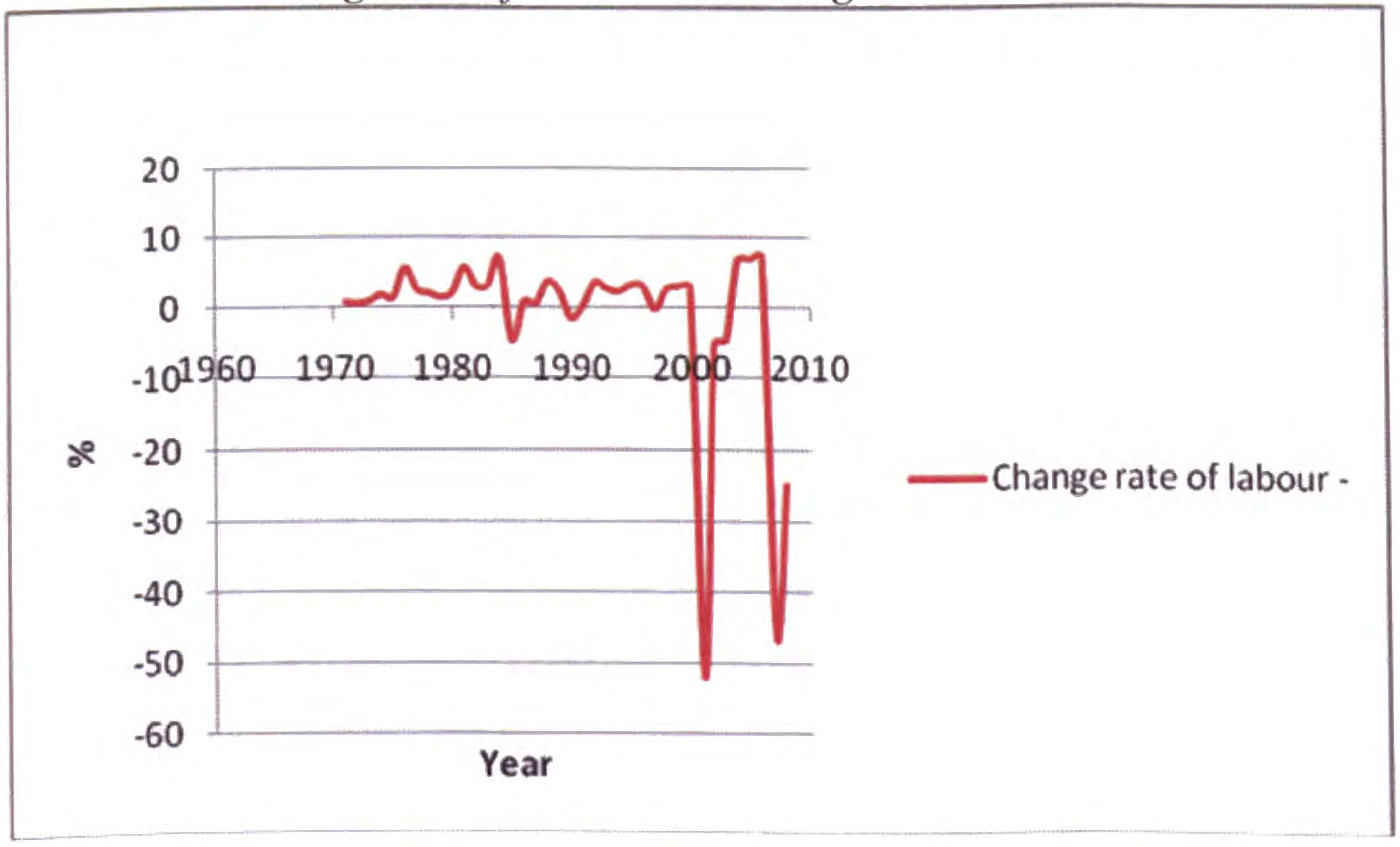


Figure 2-7

Change rate of labour used in manufacturing sector

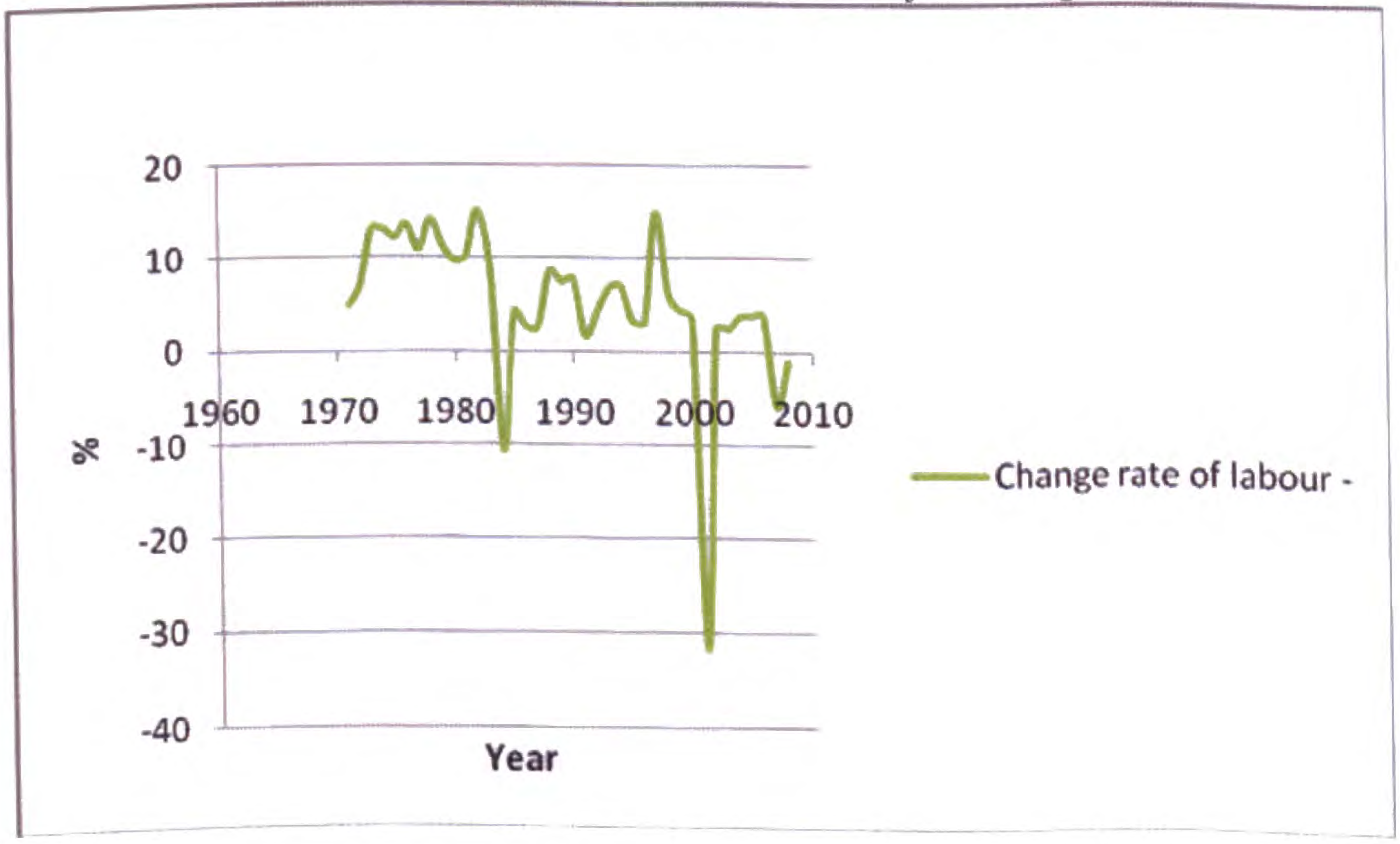
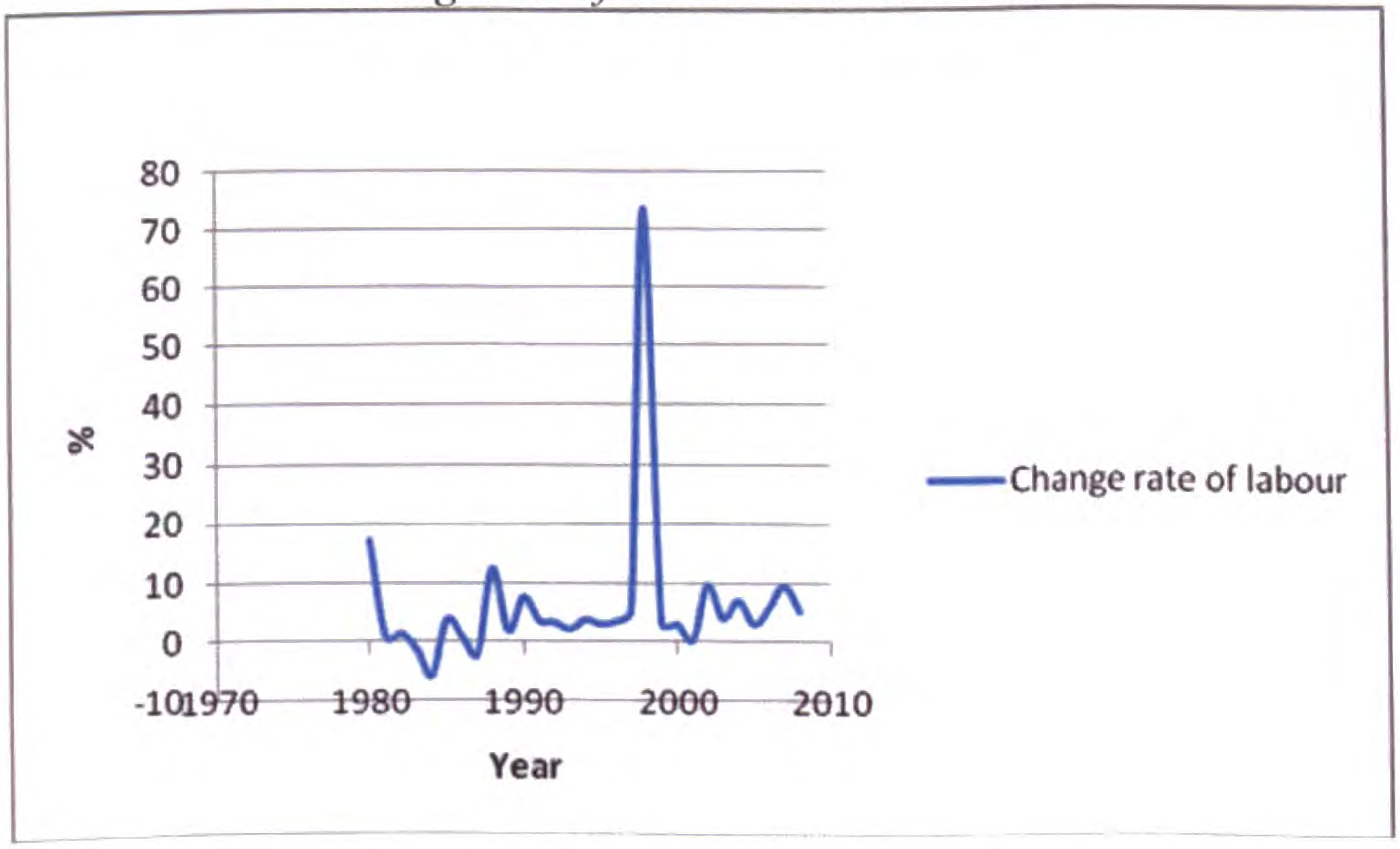


Figure 2-8

Change rate of labour used in oil sector



2-4-4. Impact of oil revenues on the Libyan economy and on productive sector during the period 1970-2008:

With the beginning of the production and export of oil, the Libyan economy felt the benefits of oil revenues, which secured the funding to spend on various goods and services. In view of the continuing increase in oil revenues and the composition surplus after providing for basic needs, thinking started about how to take advantage of this surplus to develop basic sectors in the economy. Oil revenues started to increase at the beginning of 1970 and the government began the rationalization of public expenditure between different economic sectors, in order to develop a basic infrastructure. There was a focus on education, health, roads, electricity, gas, water, transport and housing. The productive sectors such as agriculture, industry and other sectors such as tourism and the public services were also developed. All of these main sectors are a component of GDP.

Oil revenue was almost the only source of export income during the period of study. It was used as a primary source for financing administration and development budgets, because of the absence of an effective sector providing national income apart from the oil sector. This problem has been experienced by most Arab oil-producing countries (AMF, 2003).•

Table 2-9 and figure 2-9 show the evolution of oil revenue, the total real investment expenditure and their growth rates during the period 1970-2008 in the Libyan economy. Through analysis of the data in the table, the evolution of oil revenue and its growth rates can be traced during the study period.

1- There was much fluctuation in oil revenue during the period 1970-2008; its value amounted to about LD70 million in 1970, and it reached LD64417.0 million in 2008. There was also some fluctuation in oil revenue growth rates during the same period, which amounted to about -63.2% in 1977, and 547.2% in 1971.

2- Through the table it can also be seen that the oil revenues experienced much development, owing to the large increase in the oil quantities produced to cover the surge in oil demand, whether local or foreign, Libya also did not comply with its production and export quotas in OPEC; Libya exported about 3.4 million barrels per day in 1970; however the quantity decreased to half because of the prohibition on the importation of some techniques associated with the production of oil (UK Trade and Investment, 2004).

3- Oil revenues during the period 1983-1992 were dominated by large fluctuations, with a decline in most years, it ranged between LD898 million in 1989 at

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• AMF= Arabic Monetary Found

its lowest level, and LD2520 million in 1984 at the highest. This was due to a variety of reasons, including:-

- Fluctuations in international oil prices, which were dominated mostly by a decrease.
- The new policy taken by Libya to delay production and export of oil in response to decline of international prices, Libya had to reduce its oil exports despite the great need to increase oil revenues.
- Embargo imposed by the USA on the Libyan importation of oil equipment.

4- In the period 1999-2008 world oil prices began to increase with the continued increase in domestic and foreign demand on the different oil derivatives.

Through the information and data in the table 2-9 it can be noted that the value of oil revenues increased in this period, with the exception in 2000 when oil revenues decreased significantly by -36%. The increase in oil revenues during 2002-2008 was due to high oil prices, and an increase in Libya's quota scheduled from the OPEC.

Table 2-9

The evolution of oil revenue value and total real investment expenditure in the economy.

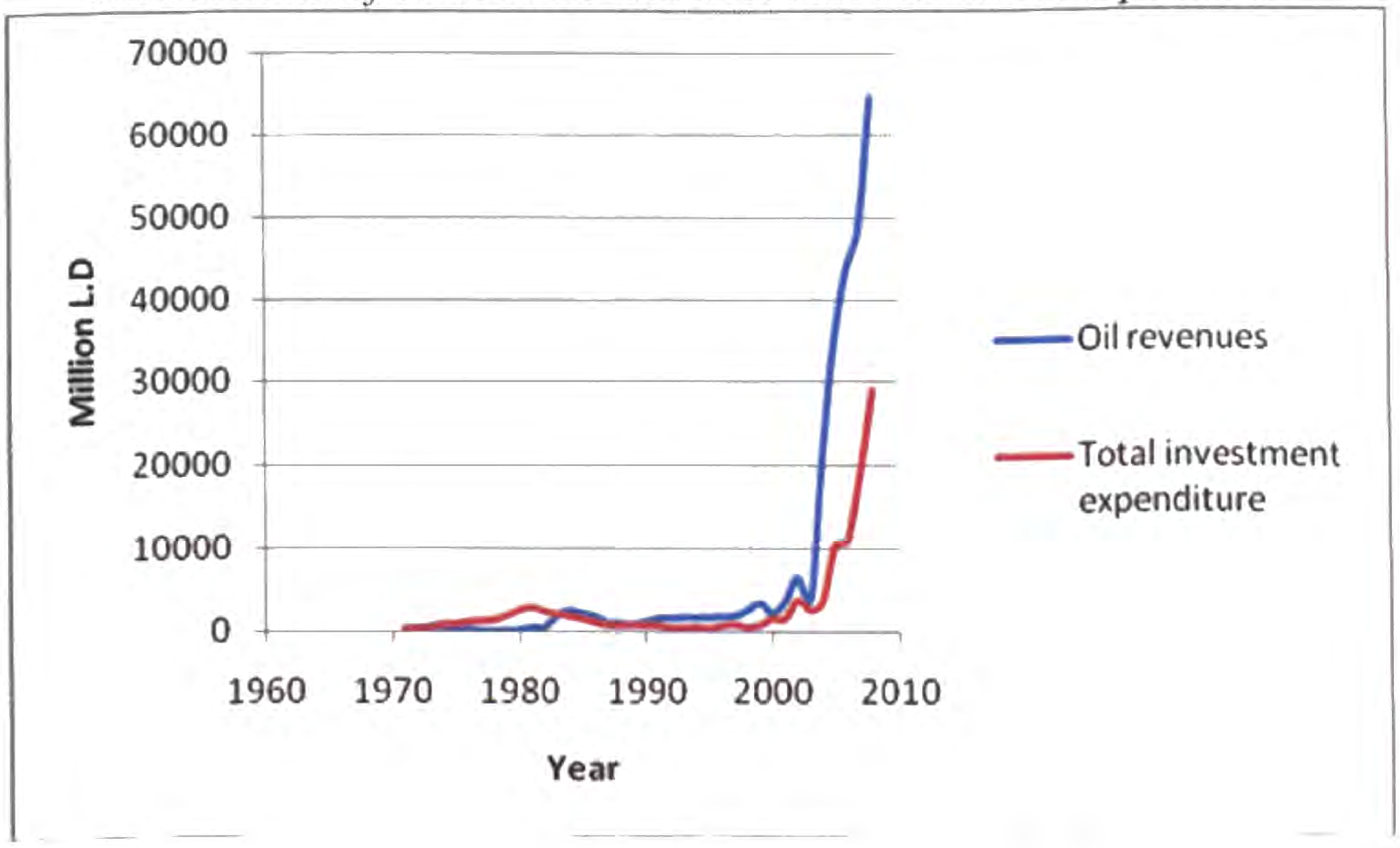
Value in Million L.D

Years	*Oil revenues (Million L.D)*	*Growth rate of oil revenues %*	*Total investment expenditure (Million L.D) (development budget)*	*Growth rate of total investment expenditure %*
1970	70	-	146	-
1971	453.1	547.2	247.6	69.5
1972	453.1	0	397.4	60.5
1973	652.3	43.9	413.8	4.1
1974	646.4	-0.9	866	109.2
1975	195.1	-69.8	923.2	6.6
1976	313.3	60.5	1187.2	28.5
1977	115	-63.2	1280.3	7.8
1978	122	6.0	1371.3	7.1
1979	162	32.7	1868.8	36.27
1980	214	32.0	2551.6	36.5
1981	565	164.0	2872.6	12.5
1982	565	0	2365.9	-17.6
1983	1920	239.8	2096.3	-11.3
1984	2520	31.2	1834.7	-12.4
1985	2125	-15.6	1523.3	-16.9
1986	1846	-13.1	1117.1	-26.6
1987	1074	-41.8	788.4	-29.4
1988	1029	-4.1	722.4	-8.3
1989	898	-12.7	823.4	13.9
1990	1181.5	31.5	702	-14.7
1991	1600	35.4	723.3	3.0
1992	1600	0	396.3	-45.2
1993	1695	5.9	405.2	2.2
1994	1700.1	0.3	507.3	25.1
1995	1725	1.4	318.9	-37.1
1996	1780	3.1	660.9	107.2
1997	1890.9	6.2	847.1	28.1
1998	2551	34.9	485.2	-42.7
1999	3444	35.0	794.1	63.6
2000	2203	-36.0	1541	94.05
2001	3603	63.5	1539	-0.12
2002	6551	81.8	3701.7	140.5
2003	3929	-40.0	2530	-31.6
2004	19956	407.9	3581.4	41.5
2005	34378	72.2	10273	186.8
2006	43566	26.7	11039	7.4
2007	48638.3	11.6	18993	72.0
2008	64417	32.4	28903.3	52.1

Sources: General Authority for Information and Documentation; Council of General Planning (the Ministry of Planning), Central Bank of Libya, IMF, World Bank; Privatization and Investment Board.

Figure 2-9

The evolution of oil revenue and total real investment expenditure



Oil revenues have had a considerable impact on the Libyan economy, especially on the growth of GDP. GDP has seen an upswing and a clear increase over the study period; it amounted to LD2019.4 million in 1997 at a minimum and to LD16392 million in 2008 at a maximum. This fluctuation was clearly due to changes in oil revenues, which were affected by many political and economic factors.

2-4-5. Public expenditure and its impact on the growth of economy and productive sector in Libya:

There has been wide debate among economists about the role of public expenditure in achieving economic growth, whether it is in developing or in developed countries. Some studies have confirmed the positive impact of public expenditure on economic growth. In earlier empirical studies, Ram (1986), and Holmes and Hutton (1990) found a positive relationship between government expenditure and economic growth. Ming and Xia, (2007) indicated that increasing R&D expenditure may lead to sustained economic growth, using data for China from

1953-2004. Lamartina and Zaghini, (2008) studied the relationship between government expenditure and economic growth of a dataset of 23 OECD advanced economies, and provided empirical evidence indicating a positive correlation between public spending and GDP growth. However, others believe that public expenditure has a negative impact on economic growth, their thinking is based on the idea that there is an inverse relationship between successful economic development and government intervention in the economy. Cumbers and Birch (2006) stated that there is no significant link between countries with high economic growth rates and government spending.

Determining the nature and magnitude of the impact of public expenditure on economic growth seems to be important, particularly for oil-exporting countries, and Libya is among these. Great efforts have been made to achieve economic growth and to expand the sources of income. Public expenditure has played a fundamental role in achieving these goals. There is no doubt that the oil revenue has had a significant influence on the components of the Libyan economy. The country used its oil revenue to obtain a stable source of national income, which led to the expansion of public expenditure: this focused mostly on consumer aspects and basic services, such as education, health, social security and the electricity sector. Also with the stability of the country politically and economically, there was a need to meet the basic requirements of citizens, especially with increased migration to large cities and increasing population growth rates, which amounted to about 4% at this time (LHC, 2006). As well as increased migration of foreign workers into the country causing an economic boom this coincided with an increase in individual incomes, which in turn led to the expansion of the import of consumer and capital goods. This in turn led to increased public expenditure.

Table 2-10

Real investment expenditure in the manufacturing and agriculture sectors and their expenditure proportional to total expenditure during the period 1970-2008

Value in Million L.D

Years	*Total investment expenditure (Million L.D)*	*Investment expenditure on the agriculture sector (Million L.D)*	*Share of investment expenditure on the agriculture sector to total expenditure %*	*Investment expenditure on the manufacturing sector (Million L.D)*	*Share of investment expenditure on the manufacturing sector to total expenditure %*	*Investment expenditure on the Oil sector (Million L.D)*	*Share of investment expenditure on the Oil sector to the total expenditure %*
	(development budget)						
1970	146	23.4	16.0	15.0	10.3	1.5	1.0
1971	247.6	47.8	19.2	29.0	11.7	15.3	6.1
1972	397.4	63.8	16.1	65.1	16.4	27.8	6.9
1973	413.8	88.9	21.5	62.5	15.1	28.5	6.8
1974	866.0	223.9	25.9	107.0	12.5	56.8	6.5
1975	923.2	242.2	26.2	100.0	10.8	52.9	5.7
1976	1187.2	288.1	24.3	165.5	13.9	67.3	5.6
1977	1280.3	263.7	20.6	160.7	12.6	67.6	5.2
1978	1371.3	281.8	20.5	157.1	11.6	80.0	5.8
1979	1868.8	379.7	20.3	210.2	11.2	93.4	4.9
1980	2551.6	489.9	19.2	583.2	22.9	55.3	2.1
1981	2872.6	487.5	17.0	530.7	18.5	57.6	2.0
1982	2365.9	308.6	13.1	409.7	17.3	25.2	1.0
1983	2096.3	252.9	12.1	455.7	21.7	19.0	0.9
1984	1834.7	262.3	14.3	381.5	20.8	18.6	1.0
1985	1523.3	182.8	12.0	289.2	19.0	129.1	8.4
1986	1117.1	120.4	10.8	201.3	18.0	1.2	0.1
1987	788.4	105.6	13.4	158.7	20.1	7.5	0.9
1988	722.4	100.0	13.8	112.8	15.6	17.7	2.4
1989	823.4	145.1	17.6	95.9	11.6	24.3	2.9
1990	702.0	217.8	31.0	35.8	5.1	16.0	2.2
1991	723.3	236.2	32.7	9.4	1.3	37.0	5.1
1992	396.3	29.2	7.4	20.2	5.1	32.6	8.2
1993	405.2	194.9	48.1	11.6	2.9	49.9	12.3
1994	507.3	14.0	2.8	35.5	7.0	26.8	5.2
1995	318.9	5.9	1.8	26.0	8.1	30.2	9.4
1996	660.9	57.4	8.7	71.3	10.8	61.9	9.0
1997	847.1	173.7	20.5	0	0	155.0	18.0
1998	485.2	61.5	12.7	3.8	0.8	42.8	8.0
1999	794.1	53.5	6.7	5.3.0	0.7	109.5	13.0
2000	1541.0	141.2	9.2	7.3.0	0.5	77.1	5.0
2001	1539.0	149.8	9.7	155.5	9.6		
2002	3701.7	183.7	4.9	369.9	22.1		
2003	2530.0	189.9	7.5	164.0	11.3		
2004	3581.4	263.0	7.3				
2005	10273.0	367.3	3.5				
2006	11039.0	175.3	1.5				
2007	18993.0	330.1	1.7				
2008	28903.3						
Average			*15.40%*		*12%*		
CAGR		*7.5%*		*7.5%*			

Sources: General Authority for Information and Documentation; Council of General Planning (the Ministry of Planning), Central Bank of Libya, IMF, World Bank; Privatization and Investment Board.

- *CAGR; Compound annual growth rata*

From Table 2-10 the following can be seen:

1- Much fluctuation can be seen in the total real investment expenditure during the period of study, ranging between LD146.0 million in 1970 as a lowest value and LD28903.3 million in 2008 as a highest value. This fluctuation in the value of investment expenditures was due to a variety of reasons, including; large fluctuations in international oil prices, and also the disparity in spending on economic sectors from year to year, as the country after 1995 followed the policy of annual expenditure (allocation of annual budget spending on sectors) rather than the development plans.

2- Since the second half of the eighties Libya has seen a decline in general revenues, prompting it to reduce its public expenditure.

3- Real investment expenditure on the manufacturing sector has seen considerable fluctuation in the period, where it amounted to about zero in 1997 as a lowest value and LD583.2 million in 1980 as a highest value.

4- The real investment expenditure in the manufacturing sector amounted to about 12% on average of total expenditure on the whole economy, at a compound annual growth rate of 7.5%, while the percentage of real investment expenditure in the agriculture sector to total investment expenditure amounted to about 15.4% on average, at a compound annual growth rate of 7.5%. These figures indicate the attention paid by the country on the productive sectors, especially agriculture and manufacturing.

From the table the evolution of growth rates of oil revenues and total real investment expenditure in the whole economy and the growth rates of real investment expenditure in the agriculture and manufacturing industries during the period of study can also be observed.

Through the data in the table the following can be deduce:

1- The annual growth rates of total real investment expenditure fluctuated during the period of study, its value ranged between -45.2% in 1992 as a lowest value and 186.8% in 2005 as a highest value, and the average annual growth rate was 24% (Table 2-10).

The reason for this fluctuation can be attributed to certain circumstances, which can be summarized in the following:

- Since the main source of Libyan national income is its oil revenues, the changes in investment expenditure have been closely associated with changes in international oil prices.
- Many political and economic circumstances were faced by the country during the study period, such as the economic blockade, which was followed by a ban on the import of equipment for oil production and industry. All of these contributed to the decline in oil revenues, followed by the decline in public expenditure.

2- The growth rates of real investment expenditure in agriculture and manufacturing also fluctuated during the same period, the value ranged between -92.8% in 1994 as a minimum rate of growth in the agriculture sector, and 872.9% in 1996 as a maximum rate of growth for the same sector, whereas growth rate values of the investment expenditure in the manufacturing sector ranged between -100% in 1997 and 137.9 % in 2002.

2-5. Summary:

The agriculture and manufacturing sectors in Libya have received an extraordinary share of attention from the government since the beginning of the seventies until the present time; this interesting is reflected in the allocation of significant financial investment to these sectors within the economic and social development plans, and also through the annual development budgets. The government aimed to increase the contribution of the GDP of non-oil productive sectors to GDP for creating much opportunity for workers and to find another resource rather than oil. However, it is clear from the analysis of the development of some economic variables during the study period 1970-2008 that the investment, which has been spent on these sectors, has not lead to the improvement of the GDP of the productive sectors. This can be seen through the following points:

- Declining contribution of the agriculture and manufacturing sectors to GDP.
- Decline in the number of workers used in both sectors, compared with the employment in the whole economy.

Because the use of descriptive analysis alone is not enough to explain changes in the GDP in these productive sectors, as well as an interpretation of the factors affecting them, the researcher needs to support these findings by using a quantitative approach.

Therefore, the following chapters will illustrate different applied economic models of production functions, in order to reach econometrics suitable for testing the production function in the productive sectors, and then to discover which are the most important factors affecting the production of these sectors.

CHAPTER THREE

Economic growth theories and production functions

A literature review

3-1. Introduction:

The history of economic growth theory goes back to the eighteenth century work of the classical economists such as Adam Smith, Thomas Malthus, David Ricardo, and later John S. Mill and Karl Marx. These classical economists were concerned with economic growth. Ricardo explained that diminishing returns from rapid population growth and a fixed quantity of land would discourage economic growth. He believed technical improvement could temporarily offset the effect of diminishing returns to scale (Kurz, 2010).

Malthus in 1798 viewed the process of economic growth pessimistically (Jones, 2003). He said that world population tends to double about every twenty-five years or so. It grows geometrically (as in the series 1, 2, 4, 6, etc.). But food output, because of diminishing returns, cannot keep pace with this. It is likely to grow at only an arithmetical rate (as in the series 1, 2, 3, 4...etc.). This meant that population would soon outstrip food supply (John, 2003). According to Malthus, starvation would occur because as population grew, so food output per head would fall until, with more and more people starving, the death rate would rise. Only then would population growth stabilise at the rate of the growth of food output.

The classical economists claimed that economic growth, profit increase and capital accumulation would recur in the short run. They stressed the importance of land as a production factor; they also confirmed the law of diminishing returns. They assumed that land as a factor cannot be increased, so when the rate of population and capital accumulation increases, the law of diminishing return will dominate. The result would be that real wages and profits would be reduced, so that investment would only be for replacement (Boianovs, 2009).

Marx showed that a decline in economic growth is associated with overproduction (Stojanov, 2007). Growth is determined by the accumulation of capital, which comes from profits. Growth of capital depends on the techniques of production. The surplus value is the difference between wage per worker and output per worker. The profit rate is a ratio of surplus value to total capital, but because of the friction between workers and employers, the result will be a fall in profit rate. The increase in wages reduces surplus value. The increase in wages is due to an increase in the number of workers, and therefore wages would increase and profit decline (Stojanov, 2007).

Most of the classical theorists were pessimistic about economic growth in the long run. They ignored the role of technical progress in economic growth, and that technical progress would improve productivity. They also underestimated the impact of technical progress in bringing about sustainable growth, because they believed that technical improvement could temporarily offset the effect of economic growth, but could not do so in the long run.

The classical economists provided the essential ideas and basic insights which have inspired modern theories of economic growth.

3-2 Harrod-Domar Growth Model:

The Harrod-Domar model is an offspring of Keynesian economics (Grabowski and Shields, 2000). In 1936, most economists were concerned with short-run theories of economic growth. Keynes assumed that capital accumulation and technological progress were fixed in the short-run. Keynes was followed by Harrod in 1939 and Domar in 1946. Their theory was an extension of Keynesian ideas about the role of the accelerator principle or multiplier on economic growth (Grabowski and Shields, 2000).

The model of Harrod and Domar attempted to describe a growing economy, especially to investigate the conditions that lead an economy to grow along a steady state path. It also attempted to explain the relationship between growth and unemployment in the economy. The Harrod-Domar model assumes a production function with no substitution between the factors of production. It assumes that saving (S) is a constant proportion (s) of output (Y).

$$S_t = sY_t \qquad (0 < s < 1) \qquad (3\text{-}1)$$

t = time

The essential variables in the Harrod-Domar growth model include capital accumulation and the ratio of change in output to change in investment, $\Delta K / \Delta Y$, since $\Delta K = I$ where ΔK is change in capital , ΔY is a change in output, and I is investment. The change in capital stock is due to investment and the change in output is a result of a change in capital stock. So investment can be shown as an equation of change in output, as follows:

$$I = v(Y_t - Y_{t-1}) \qquad (3\text{-}2)$$

where:

$(Y_t - Y_{t-1})$ = the change in output between year t and year $t-1$.

v is the ratio of extra capital accumulation or investment to the flow of output.

Harrod-Domar said that stability of the economy requires that $S = I$.

So, from equations 3-1 and 3-2:

$$v \ (Y_t - Y_{t-1}) = sY_t \qquad (3\text{-}3)$$

If both sides of equation 3-3 were divided by Y_t and v, the result would be as follows:

$$\frac{Y_t - Y_{t-1}}{Y_t} = \frac{s}{v} \qquad (3\text{-}4)$$

This is the growth rate of output, and it is the warranted growth rate G_w, as defined by Harrod-Domar. This expression for the warranted growth rate in 3-4 is definitionaly true since it expresses the accounting identity that saving equals investment (Grabowski and Shields, 2000).

The Harrod-Domar model defined three types of growth rates: warranted (G_w), actual (G), and natural (G_n) growth rates. To achieve economic equilibrium, these three different types of growth rate must be equal to each other. For example, if the actual growth rate is less than the warranted one $G < G_w$, that is, $\Delta K / \Delta Y < I / \Delta Y$, there will be a surplus of capital goods and investment will be discouraged, causing the actual growth rate to fall even further below the equilibrium rate, in other words if warranted growth rate exceeds the actual growth rate. This means that the level of investment required will appear lower than actual investment and actual saving. The reason is that actual investment depends on the level of change in income, determined by the actual growth rate. Therefore, economic agents will think that they have a surplus in their production. So, Harrod states that these agents will reduce their production in future. As a result, the outcome would be worse, because the difference (gap) between the actual and warranted growth rates will increase in later stages. Harrod said that this action would lead to redundancies, leading to increased unemployment and a declining price level; this is a deflationary gap.

On the other hand, if the actual growth rate exceeds the warranted growth rate; $G > G_w$, that is, $\Delta K / \Delta Y > I / \Delta Y$, then the level of investment required would appear greater than the real one. Thus agents would think that their production is insufficient, and should be increased. But a different problem would occur. An inflationary gap will appear, because the economic agents will face a deficit in productive capacity.

The third type of growth suggested by the Harrod-Domar growth model is the natural growth rate, which is denoted by Gn. It represents a full employment growth rate; the natural growth rate is considered as maximum growth rate achieved by increases in labour force and capital accumulation. The natural growth rate is derived from the identity $Y = L(Y/L)$ where L is labour and Y/L is the productivity of labour, or, taking the rate of growth; $Y = i + g$. The natural growth rate is therefore made up of two components: the growth of the labour force (i) and the growth rate of labour productivity (g) and both are exogenously determined (Thirwall, 2006).

The Harrod-Domar growth model assumes full employment with fixed coefficients of production; the full employment of labour clearly requires that $G = G_n$; the full employment of labour and capital requires that $G = Gw = Gn$.

Therefore, if the warranted growth rate is equal to the natural one, there will not be a tendency for unemployment and inflation to rise. However, if the warranted growth rate is less than the natural one, unemployment will rise, even if the warranted growth rate is equal to the actual one, because the actual and warranted growth rates are less than the natural one.

On the other hand, the Harrod-Domar model assumed that if the warranted growth rate is greater than the natural one, this would be a temporary situation, because the actual growth rate would be unable to exceed the natural one in the long run. Thus, if full employment were achieved, the actual growth rate would tend to decline, and unemployment would result.

The Harrod-Domar growth model suggests that monetary and financial policies should lead to the warranted, actual and natural growth rates being equal. However, the Harrod-Domar model is pessimistic about the possibility of these policies achieving their aims. Saving and investment functions in the Harrod-Domar model are simple, and the model has been criticised by Solow and others (Agata and Freni, 2003). The failure of the model concerning the possibility of achieving steady growth at its potential level was the reason for the introduction of a new growth model that allowed for substitution between economic variables, such as the neoclassical growth model. This model is examined in the next section.

3-3. Neo-classical growth theory

The neo-classical growth model was first developed by Solow and Swan in 1956. They provided the basic model yielding the most analytically satisfactory approach to the problem of divergence between the natural and warranted growth rates (Thirlwall, 2006). The neo-classical growth model assumes a closed economy with a competitive market. It took all the assumptions in the Harrod-Domar model as given except the assumption of fixed proportions of input (Ghosh, 2008). Output is a function of capital and labour $Y = f(K, L)$. The production function relates output to input factors, and has a unitary elasticity of substitution between factors. If the quantity of both input factors were to increase by the same percentage, output would also increase by the same percentage. Y is determined by the interaction of capital and labour, that is $Y = f(K, L)$. The model predicts long-run growth equilibrium at the natural rate, so that output, capital and labour all grow at the same rate. The most commonly used neoclassical production function with constant return to scale is the Cobb-Douglas production function:

$$Y = A^{ert} K^{\alpha} L^{1-\alpha} \tag{3-5}$$

where Y, K and L are output, capital and labour respectively, A^{ert} is an index of technology or total factors productivity (TFP), A is constant, e is the natural logarithm and equal to 2.7180, r is the rate of technical progress, t is time, α is the elasticity of output with respect to capital, $1-\alpha$ is the elasticity of output with respect to labour, and $\alpha + (1-\alpha) = 1$. A 1% increase in K and L will lead to a 1 % increase in Y, which is expressed by output exhibiting Constant Returns to Scale (CRS). The Cobb-Douglas production function refers to diminishing returns of the production factors; when one is held constant, and another increased, the latter factor will yield diminishing returns.

The neoclassical theory assumed that change in technology is exogenous (Thirlwall, 2006). It depends on changes in input factors, and that the effect of technical progress on the factor intensity of production is natural. Explaining the influence of three sources of growth form can be done by taking logarithms of the variables and differentiating both sides of equation 3-5, with respect to time, which gives:

$$\frac{\partial \log Y_t}{\partial t} = \frac{\partial \log T_t}{\partial t} + \alpha \frac{\partial \log K_t}{\partial t} + \beta \frac{\partial \log L_t}{\partial t}$$

or

$$\frac{dY}{dt} \times \frac{1}{Y} = (\frac{dT}{dt} \times \frac{1}{T}) + \alpha(\frac{dK}{dt} \times \frac{1}{K}) + \beta(\frac{dL}{dt} \times \frac{1}{L}) \qquad (3\text{-}6)$$

where:

$T = A^{ert}$ and $\beta = 1-\alpha$

Technology is assumed to grow at a constant rate.

$$\frac{dY}{dt} = rA^{ert}K^{\alpha}L^{1-\alpha} + \alpha A^{ert}K^{\alpha-1}L^{1-\alpha} * \frac{dK}{dt} + (1-\alpha)AertK^{\alpha}L^{-\alpha} * \frac{dL}{dt}$$

Since:-

$$K^{\alpha-1} = \frac{K^{\alpha}}{K} \qquad \text{and} \quad L^{-\alpha} = \frac{L^{1-\alpha}}{L}$$

So

$$\frac{dY}{dt} = rA^{ert}K^{\alpha}L^{1-\alpha} + \alpha A^{ert}K^{\alpha}L^{1-\alpha}(\frac{1}{K} * \frac{dK}{dt}) + (1-\alpha)A^{ert}K^{\alpha}L^{1-\alpha}(\frac{1}{L} * \frac{dL}{dt})$$

So

$$\frac{dY}{dt} * \frac{1}{Y} = (\frac{dT}{dt} * \frac{1}{T}) + \alpha(\frac{dK}{dt} * \frac{1}{K}) + \beta(\frac{dL}{dt} * \frac{1}{L})$$

Or

$$rY = rT + \alpha rK + \beta rL \qquad (3\text{-}7)$$

where rY is the growth rate of output per time period, rT is the growth rate of total factors productivity, or technical progress, rK is the growth rate of capital, rL is the growth rate of labour, and α and β are the partial elasticity of output with respect to capital and labour respectively.

In other words, in equation 3-7, growth rate of output is equal to the sum of growth rates of technical progress (weighted by growth of total productivity), the growth rate of capital (weighted by the partial elasticity of output with respect to capital), and the growth rate of labour (weighted by the partial elasticity of output with respect to labour).

Neo-classical theory holds that economic equilibrium requires that capital, labour and technical progress must grow at constant rates. So, if we assume that labour grows at a constant rate rL, according to Keynes and Harrod we know that $\Delta K = I$, and that economic equilibrium requires

$$I = S \qquad \text{and} \qquad S = sY$$

$$\text{So,} \quad I = sY \qquad \text{or} \qquad \Delta K = sY \tag{3-8}$$

We can also rewrite the equation 3-8 by dividing both sides of the equation by K, to give output per head as a function of capital per head:-

$$\frac{\Delta K}{K} = s\frac{Y}{K} \qquad \text{OR} \qquad rK = s\frac{Y}{K}$$

where s is a portion of output and is constant, so the capital–output ratio must be a constant. Neoclassical theory assumes a constant natural rate of growth of capital-output ratio.

In other words, the growth rate of output (rY) is equal to the growth rate of capital (rK). Equation 3-7 defines the relationship between rY and rK, which keeps these growth rates constant and equal to each other, that is $rY = rK$. This equation can be written as:-

$$rY = \frac{rT}{1-\alpha} + rL \tag{3-9}$$

where rY refers to the equilibrium growth rate of capital and output. That is, the equilibrium growth rate depends on the growth rates of labour and technical progress. If one increases, the equilibrium growth rate will also increase.

However, if there is no technical progress or the growth rate of technical progress is equal to zero or is fixed ($rT = 0$), the rY equilibrium growth rate will be equal to the growth rate of the labour force (rL). Since the capital stock must grow by the same growth rate of output, then, in this case, it must grow by the same rate as labour.

On the other hand, if the growth rate of technical progress is positive, output and capital stock will grow at the same rate, but their growth will exceed the growth of labour, and the resulting income per capita will increase.

The contents of neo-classical theory differ from those in the Harrod-Domar model. Unemployment is not a factor in neo-classical theory, because it assumes full employment. As a result, there is no difference between the warranted growth rate and the natural one, as in the Harrod-Domar model. In neoclassical theory, the increase in growth rates of labour and technical progress lead to an increase in the equilibrium growth rate, whereas, in the Harrod –Domar model, the increase in growth rates of labour and technical progress lead to an increase in the natural growth rate, but not necessarily to an increase in the warranted and actual growth rates.

As mentioned previously, capital stock and output grow at the same rate. Therefore, the output level of per capita consumption can be determined from the saving rate, which maximizes per capita consumption. This is due to the fact that the rate of saving which maximizes per capita consumption at a point in time = 0 is the same rate which maximizes consumption at other points. So, if $t = 0$, the Cobb-Douglas production function will take the following form:

$$Y = AK^{\alpha} L^{1-\alpha} \qquad (3\text{-}10)$$

where $e^{rt} = 1$. By dividing both sides of the last equation by L, this form is obtained:

$$\frac{Y}{L} = \frac{AK^{\alpha} L^{1-\alpha}}{L} = AK^{\alpha} L^{-\alpha}$$

or

$$\frac{Y}{L} = A(\frac{K}{L})^{\alpha} \qquad (3\text{-}11)$$

where $\frac{Y}{L}$ is per capita output, and $\frac{K}{L}$ is the capital-labour ratio. Equation 3-11 shows that per capita output depends on the capital-labour ratio.

Robinson and Kaldor, who are members of the Cambridge school, criticized the assumption of full employment in neo-classical theory (Sanfilippo, 2008). Neo-classical theory assumes that prices of production factors are flexible enough to achieve full employment. Therefore, investment is always equal to savings at the full employment point. The criticism of neo-classical theory raises a question, which is whether the prices of production factors are flexible enough to achieve full employment. In fact the rigidity of production factors is a short-term phenomenon, while the prices of production factors in the long term are more flexible, which achieves full employment. The monetary and financial authorities can provide a numbers of policies to achieve full employment.

Sato in 1963 stated that 100 years might be needed to reach 90% of growth rate from its first level, in response to an increase in the savings rate. This means that economic policies concerned with an increase in the savings rate will be successful in increasing the growth rate of the economy in the long run. Sato in 1963 argued that the Harrod-Domar model may be more important to an economy than the neo-classical model. Another criticism of neo-classical theory is that it does not contain an explicit investment function, and it ignores expectations, and both are important factors in the Harrod-Domar model (Mino, 2002).

However, full employment does not require the investment function, because investment is determined by savings at the point of full employment. There has been widespread controversy about the validity of neo-classical theory. Some economists such as Lucas (1988) and Romer (1990) say that many of the assumptions of neo-classical theory are useful to explain reality. Other economists, however, including Sato(1963) argue that the Harrd-Domar model is the most useful theory to describe reality, at least in the short run. A problem with neo-classical growth theory is that it assumes that there will be an inverse relationship across countries between the capital-labour ratio and the productivity of capital. So, poor countries with a small amount of capital per head should grow faster than rich countries with great deal of capital per head, leading to the convergence of per capita incomes and living standards across the world (Ruttan, 1998). The basis of this claim is that poor countries with a low capital-labour ratio will exhibit higher productivity of capital. That means that the ratio of investment to gross domestic product must be the same across countries. New growth theory attempts to overcome this shortcoming of neo-classical growth theory. It also attempts to explain how the rate of technological change is determined.

3-4. New (Endogenous) Growth Theory:

The new growth theory runs contrary to the prediction of the neo-classical growth theory based on the assumption of diminishing capital, which, given identical preferences and technology across countries, should lead to faster growth in poor countries than in rich ones (Thirlwall, 2006). The result of this is that in the long-run the growth rates in different countries will be equal. The new growth theory relaxes the assumption of diminishing returns to capital and shows that, with constant or increasing returns, it cannot be assumed there is convergence of per capita income across the world, as the neoclassical theory does (Thirlwall, 2006).

The new growth theory's assumption is that there are no diminishing returns to capital, investment is important for long run growth and growth is endogenous in this sense. The new growth model of endogenous growth was pioneered by Robert Lucas in 1988 and Paul Romer in 1986 and 1990, (Thirlwall, 2006). Romer states that there are positive externalities, such as education, training, and research and development (R&D), which prevent the marginal product of capital from falling, and the capital-output ratio from rising. So we can assume the production function of capital as follows:

$$Y = AK^{\alpha} \tag{3-12}$$

where K is a composite measure of capital (physical capital plus other types of reproducible capital), and $\alpha = 1$ (Lucas, 1988) and (Rome, 1986, 1990). The global absence of diminishing returns becomes plausible if K includes human capital, as can be seen from the expression for the capital-output ratio:

$$\frac{K}{Y}=\frac{K}{L}\bullet\frac{L}{Y} \tag{3-13}$$

Anything that raises the productivity of labour (Y/L) in the same proportion as K/L will keep the capital-output ratio constant. Arrow (1962) and Kaldor (1957) said that technical progress affects the productivity of labour, in addition to as technological spill-over from trade. Grossman and Helpman (1991), and De Mello (1999) add the possibility of the effects of education, and research and development on growth in their model.

Romer (1994) states that economic growth is an endogenous outcome of an economic system, not the result of factors impinging on it from outside. The model is based on the assumption of increasing returns to scale due to spill-over effects from ideas. Romer (1986) believed that the process of innovation and invention drives technical progress; he argued that technology emanates from new ideas.

Endogenous growth is knowledge based in the Lucas model. Lucas (1988) argued that investment in human capital through education and training will not only increase the return for the individual, but will also be beneficial for the society as a whole. In other words, the productivity of a worker is not only enhanced by his/her individual skills but also by the average skills of his/her fellow workers. Coe and Helpman (1995) argued that technological improvements may depend on research and development (R&D) in other countries.

The endogenous growth model is in contrast to neo-classical theory in predicting convergence, as it assumes a constant or even increasing return to capital. It also gives several reasons to explain these disequilibrating forces. Even if marginal returns to capital are higher in low income economies, the capital market may be too inflexible and inefficient for capital to flow there. Further, high income regions may be likely to save more as a result of higher incomes, and these savings may be reinvested in the economy, fostering economic growth. Migration may have a harmful effect on the age structure in poor regions if their young and well trained residents move to high income and high wage economies (Desdoigts, 2004).

3-5. The Club of Rome (or the classical theory of economic growth revisited):

The Club of Rome model maintains that if the current trends of population growth, food production, industrialization, environmental pollution and resource depletion continue, economic growth will stop in less than 100 years. This model was developed by Donella, Meados, Randers, William and Behrens (Simmons, 2000). They cited five essential factors affecting economic growth; population, food production, industrialization, environmental pollution and resource depletion. The model states that each factor grows at an exponential rate. In 1650 the world population was growing at 0.3% (King, 1972). This means the world population needed 250 years to double.

However, the growth rate of world population was 2.1% in 1970, which meant that it would double every 32 years (King, 1972). The club of Rome model said the problem is not only confined to the doubling of the population, but also related to the future of food quantity in the world, because many of the world's population will be denied food, the best land is cultivated, and an insufficient supply of water may limit the growth of food production.

The model also doubted the ability of technology to compensate for the relative scarcity of land and water. The model recognized that industrial output grew more rapidly than population in the past. It suggested that the growth rate of industrial production would be reduced in the future, because of the depletion of non-renewable economic resources, such as aluminium, copper, natural gas and oil.

The model confirmed that with an increase in the population compared to the limited food supply, the poverty rate would increase, as would the rate of mortality, because of the high level of pollution, resulting in a reduction in the world population. Reduction in population, the high levels of pollution and the depletion of global natural resources would all be causes of a reduction in industrial output.

The model supposed that population, pollution and the scarcity of resources would grow faster than technical progress. Consequently, industrial output and food production would not keep pace with population growth, whereas previous studies have confirmed that technical progress also grows at an exponential rate.

The model confirmed that policies must be adopted, either at present or in future, in order to reduce these problems. These policies including, for example, reducing birth rates, would not be sufficient to solve these problems indefinitely.

However, the model stressed that to prevent the collapse of the world economy, both population and industrial output must be stabilized, in order to obtain relatively high levels of industrial output and foods at the individual level, although a lack of economic resources would eventually lead to these being reduced. The Club of Rome model was criticized by energy economists (Simmons, 2000), especially for neglecting the role of technical progress. The Club of Rome model also failed to explain why technical progress would grow slowly in the future, There have also been some studies, for example Peron, (1995) which have confirmed that the growth rate of population would increase rapidly, but the decline of per capita income, and the population problem could be solved by a decline in birth rates.

3-6. Production functions and economic growth:

The correct way to analyse the impact of production factors and technical progress on economic growth is to study the production function. The production function is a tool used to explain the relationship between output and production factors. Many problems were faced by the researcher in this field in attempting to achieve the main aim of this study, which is to specify accurately which production function is most suitable for analysing economic growth in the Libyan economy. There are different options, but they amount to a choice between the two most widely used functions, which are the Cobb-Douglas (C-D) production function pioneered by Charles Cobb and Paul Douglas, and the Constant Elasticity of Substitution (CES) production function (Milojevic and Grozdanovic, 1997).

There are also different technological alternatives which are present for producing output, each of which requires a different and appropriate combination of factors of production. These relationships between production factors and output, and between the factor inputs themselves are presented by existing technical progress, so that it is possible to define both kinds of technical progress, i.e. neutral and non neutral.

The production function is a mathematical relationship between groups of factors involved in the production process over a period of time. The production function can be written in general form as follows:

$$Q = f(X_1, X_2, \ldots\ldots\ldots X_n) \qquad (3\text{-}14)$$

This equation denotes the possibility of producing an amount of Q by using a number of production factors which are $X_1, X_2, \ldots. X_n$,this relationship can be shown by f. There are two types of production factors, fixed and variable factors. The difference between the production factors is related to the time period. Some of the production factors are fixed and others are variable in the short-run. Change in output in this case is because of changes in the variable factors. Classical economists stated that change in output is due to changes in capital stock, whereas in the Harrod-Domar model the cause of change in output is changes in capital stock and technical progress in the short-run. However, supporters of the neo-classical and endogenous theories attribute the change in output to change in technical progress, and economic growth can be long term.

There are many types of production function in the economic literature, such as the Cobb-Douglas, Constant Elasticity of Substitution, Variable Elasticity of Substitution, Trans log and Leontief production functions.

However, the Cobb-Douglas(C-D) and Constant Elasticity of Substitution (CES) production functions have been chosen in this study, because they are more commonly used (Thrilwall, 2006). These two production functions are reviewed in the following sections.

3-7. The Cobb-Douglas(C-D) production function:

The Cobb-Douglas production function was pioneered by Charles Cobb (a mathematician) and Paul Douglas (an economist). They analysed the production function of the USA economy in 1928 (Thirlwall, 2006). The Cobb-Douglas function is very commonly used, and it can be written as:

$$Q = AK^{\alpha} L^{\beta} \tag{3-15}$$

where Q is real output at a period of time, A is a constant amount which reflects the efficiency of production factors used, L and K are an index of labour and capital respectively, α is the elasticity of output with respect to capital, and β is the elasticity of output with respect to labour. These two parameters of labour and capital can be used to determine the homogenous degree and returns to scale of production function. A time variable will be included in the production function. Thus the function will take the following form:-

$$Q = AtK^{\alpha} L^{\beta} \tag{3-16}$$

At is an index of technology or total productivity where t is a time variable.

However, the original form of the C-D production function cannot be estimated directly, because it is not linear in its parameters. Therefore, the C-D function can be represented in a log linear form as follows:-

$$\ln Q = \ln At + \alpha \ln K + \beta \ln L \tag{3-17}$$

where α and β are regression coefficients, the sum of these coefficients giving the scale of return, or the degree of homogeneity of the function. So $\alpha + \beta = 1$ represents constant returns to scale, that is, increases in K and L by 1% will increase output by the same percent, and $\alpha + \beta > 1$ represents increased returns to scale, that is, an increase in production factors L and K by 1%, will increase output by more than 1%, but if $\alpha + \beta < 1$, an increase in factor inputs by 1% will increase output by less than 1%; this is called decreased return to scale.

On the other hand, if we assume that production factors increase by amount r, where r is a percentage.

L will increase by $$L(1+\frac{r}{100}) \tag{3-18}$$

K will increase by $$K(1+\frac{r}{100}) \tag{3-19}$$

In this equation output would increase by as much, less or more than the value of r based on constant or decreased or increased return to scale. By compensating the value of K and L from equations (3-18) and (3-19) in the original form of C-D production function, the following form can be obtained:

$$Q(1+\frac{r}{100})^{\alpha+\beta} = A(L(1+\frac{r}{100})^{\beta} \quad K(1+\frac{r}{100})^{\alpha}) \tag{3-20}$$

The function is said to be homogenous at one degree, greater than, and less than one attributed to $\alpha + \beta = 1$, $\alpha + \beta > 1$ and $\alpha + \beta < 1$ respectively.

The Cobb-Douglas production function is often employed in constrained form with the sum of α and β put equal to unity. The underlying assumption is perfectly competitive if production is subject to constant returns and factors are paid to the value of their marginal products. Therefore, the average and marginal product of factors can be quantified. The average of factor inputs is expressed by dividing output by production factors and can be written mathematically as follows:-

$$AP_L = \frac{Q}{L} = \frac{AK^{\alpha}L^{\beta}}{L} \qquad (3\text{-}21)$$

$AP_L = AK^{\alpha}L^{-\alpha}$ since $\beta = 1-\alpha$

Thus:-

$$AP_L = A(\frac{K}{L})^{\alpha} \qquad (3\text{-}22)$$

where AP_L represents average product of labour factor.

However, marginal productivity of factor inputs is equal to change in output divided by change in factor inputs. In other words, it is first derivative of output with regard to the factors of production, and can be written mathematically as follows:

$$MP_L = \frac{\partial Q}{\partial L} = 1-\alpha AK^{\alpha}L^{-\alpha} \qquad (3\text{-}23)$$

since $\beta = 1-\alpha$ Thus:-

$$MP_L = 1-\alpha A(\frac{K}{L})^{\alpha} \qquad (3\text{-}24)$$

where MP_L represents the marginal productivity of labour. AP_K and MP_K can be quantified in the same way that used for quantify marginal and average productivity of labour. From equations 3-23, 3-24, the following equation can be concluded:

$$MP_L = \beta AP_L \qquad (3\text{-}25)$$

3-7-1. The C-D production function and technical progress:

The C-D production function quantifies two types of technical change, which are neutral and non-neutral. Neutral technical change is expressed by a change in constant term A in the C-D production function, or by a change in returns to scale $\alpha + \beta$, which is, change in degree of homogeneity of the function. However, this type of technical change does not change the ratio of marginal product and the ratio of labour to capital (Dupuy, 2005).

The second type of technical change, which is the non-neutral one, refers to change in the relationship between the production factors themselves. It means the elasticity of substitution of production factors would change. Therefore, if the α/β increased, the technical change would be capital saving. That is, the technical change would raise the marginal product of labour in greater proportion than the marginal product of capital (Thilwall, 2006).

However, if the α/β ratio decreases, it means that technical change would be labour saving. That is, the technical change would raise the marginal product of capital in greater proportion than the marginal product of labour (Thirlwall, 2006).

3-8. *The Constant Elasticity of Substitution production function (CES):*

The CES production function in the case of using two factors of production function can be expressed as follows:

$$Q = A[\ \delta K^{-\rho} + (1-\delta)L^{-\rho}]^{\frac{-\varepsilon}{\rho}} \qquad (3\text{-}26)$$

where Q is output, K and L are capital stock and labour respectively, A, δ are the efficiency and distribution parameters of output with regard to production factors respectively, where $1 > \delta > 0$,and the ρ is the substitution coefficient between the production factors, where $\rho \geq -1$.

The CES production function was introduced by Dickinson in 1954. Consequently, it was used by Arrow, Chenery, Minhas and Solow in 1961 (Temple, 2008). There has been much emphasis in the literature on the fact that the elasticity of substitution is not necessarily equal to one, as in the C-D production function. Some of the characteristics of the CES function are that it is homogenous at degree one if $\alpha + \beta = 1$, and it has unity elasticity of substitution only if $\rho = 0$.

Therefore, the C-D production function can be a special case of the Constant Elasticity of Substitution production function. The marginal productivity of production factors can be quantified as following:

Marginal product of labour can be through differentiation equation 3-26 with respect to L, and this can be written mathematically as:

$$MP_L = \frac{\partial Q}{\partial L} = \frac{\alpha}{A\rho}(\frac{Q}{L})^{\rho+1} \qquad (3\text{-}27)$$

And the marginal product of capital (MP_K) is:-

$$MP_K = \frac{\partial Q}{\partial K} = \frac{1-\alpha}{A\rho}(\frac{Q}{K})^{\rho+1} \tag{3-28}$$

However, the average product of production factors in the CES production function is expressed by the division of output with respect the factors K and L, this can be written mathematically as follows:

$$AP_L = \frac{Q}{L} = \frac{A}{L}(\delta K^{-\rho} + (1-\delta)L^{-\rho})^{\frac{-\varepsilon}{\rho}} \tag{3-29}$$

And

$$AP_K = \frac{Q}{K} = \frac{A}{K}(\delta K^{-\rho} + (1-\delta)L^{-\rho})^{\frac{-\varepsilon}{\rho}} \tag{3-30}$$

Where AP_L and AP_K are the average product of labour and capital factors respectively.

3-8-1. The CES production function and technical progress:

Similar to the Cobb-Douglas production function, the CES production function also quantifies two types of technical change, which are neutral and non-neutral technical change. However, in the CES production function, neutral technical change refers to change in technological efficiency and return to scale.

The non-neutral technical change rate affects the relationship between the production factors and then the ratio of marginal product of these factors. Hicks in 1932 stated that the non- neutral technical change either affects the capital factor (labour saving), or affects the labour factor (capital saving). It can be seen as the following:

$$H = \frac{\partial \ln MRTS_{KL}}{\partial L}$$

Where H and $MRTS_{KL}$ are Hicksian neutrality and marginal rate of technical substitution between capital and labour respectively, and H is equal to or more or less than zero. Mathematically:

$$MRTS_{KL} = \frac{MP_K}{MP_L} = \frac{\partial Q}{\partial K} / \frac{\partial Q}{\partial L}$$

Thus

$$MRTS_{KL} = \frac{\delta}{1-\delta}(\frac{L}{K}) \qquad (3\text{-}31)$$

Non-neutral technical change also affects the δ value which denotes the parameter of capital factor. If the value of δ increases, the value of the marginal rate of technical substitution between capital and labour also increases. Non-neutral technical change also affects the value of the elasticity of substitution of production factors (σ). This shows that Hicksian neutrality is a function of capital intensity and the elasticity of substitution (McAdam and Willman, 2009).

3-9. Summary:

Five types of economic growth theory have been explained in this thesis, two of them (neo-classical and endogenous growth theories) support the possibility of economic growth in the long-run, but the others (Classical economists, The Club of Rome and Harrod and Domar models) do not. Classical economists such as Adam Smith, Thomas Malthus, David Ricardo, and later John S. Mill and Karl Marx viewed the process of economic growth pessimistically, believing it would eventually end, and economic stagnation would be the result, because of diminishing returns to factors. In other words, classical economists believed that economic growth would be only in the short-run, and the growth of an economy is determined by the accumulation of capital. They ignored the role of technical progress and its impact on economic growth. They also stated that technical progress may postpone economic recession, but not indefinitely. The Club of Rome model also doubted the ability of technological progress to improve economic growth. It believed that there are essential factors affecting economic growth, namely population, food production, industrialization, environmental pollution and resource depletion. They supposed that those five factors grow at an exponential rate, and faster than technical progress. Therefore, their theory asserts that economic growth would stop in less than 100 years, because of the growth or otherwise of the five essential factors.

Despite the pessimistic view regard economic growth in long-run, classical economists provided essential ideas and basic insights, which inspired modern theories of economic growth. Harrod and Domar were concerned with explaining the relationship between the growth of the economy and growth of labour. They also believed that economic growth in the long-run is impossible.

Consequently, the neo-classical and endogenous growth theories came to explain the possibility of economic growth in the long-run. Neo-classical theory has adopted all the assumptions as given in the Harrod-Domar model, except the assumption of fixed proportion of inputs. Neo-classical theory assumed the possibility of substitution of inputs in the production process in the long-run. It had a vital role in shedding light on essential variables (technical progress and capital accumulation) which influence the productivity of factor inputs.

However, the shortcoming of neo-classical theory, as the endogenous growth theory stated, is the assumption that poor countries will grow faster than rich ones, leading to the convergence of per capita income across countries. Endogenous growth theory also criticised the assumption within neo-classical theory that technical progress is exogenous.

Many economists are not satisfied with the exogenous nature of technological advancement, which is the major source of growth in the steady state in the Solow model. Building on this learning in his literature, Schultz (1961), Arrrow (1962), Becker (1964), Lucas (1988) and Romer (1989) have made technology endogenous by introducing knowledge or human capital into the production function along with physical capital. Lucas models human capital accumulation to be a direct outcome of time spent on studying and learning rather than at work. If people spend more time in studying, they learn more and become more skilled. This raises per capita human capital available in the economy, which complements physical capital and raises the skill and the productivity of workers. Such a rise in productivity is the major source of economic growth.

Barrow and Martin (1995) believe that technical progress is endogenous. They also assume the absence of diminishing returns to capital, especially when the capital includes human capital, and their assumption is based on the fact that there are positive externalities which affect the productivity of labour, such as education, training, and research and development (R&D), as well as technological transfer. This will cancel the assumption that poor countries will grow faster than rich ones, as well the assumption of convergence of per capita income across the world (Felipe and Combie, 2005).

According to neo-classical and endogenous growth theories, it can be seen that there is the possibility of economic growth in the long-run, and this mainly depends on labour, capital, and the factors which affect the productivity of these elements, such as technical progress. This chapter also focused on the two most commonly used production functions, viz Cobb-Douglas (C-D) and Constant Elasticity of Substitution (CES) and the way in which they handle technical progress.

The natural question in this case is which form of production function will be adopted, in other words, which one is more suitable for the Libyan economy. Several empirical studies have tried to explain the source of economic growth in different parts of the world, using both CD and CES production functions. Some of these studies state that the Cobb-Douglas production function is more suitable for developing countries. This question will be addressed in this study. A production function has several useful features, as it brings together economic theories and statistical methods.

Previous empirical studies which have used both Cobb-Douglas and Constant Elasticity of Substitution production functions, based on neo-classical and endogenous growth theories, will be described in next chapter, in order to explain the relative importance of factors which affect economic growth in the long-run.

CHAPTER FOUR

Economic Growth and Production Functions

A Review of Empirical Studies

4-1. Introduction:

The aggregate production function has been used as a tool to measure a wide range of economic aspects, whether at the national or international levels. The relationship between output and inputs has been explained by using mathematical and statistical methods.

However, the production function has many forms, such as the Leontief, linear Trans log Form, the Cobb-Douglas (C-D), the Constant Elasticity of Substitution (CES) and the Variable Elasticity of Substitution (VES) production functions. This study focused on the two most commonly used kinds of production function, which are the C-D and the CES production functions. This chapter reviews some of the empirical studies, in particular those studies which use the same tools analysing the relationship between output and inputs, especially the contribution of the factor inputs in gross domestic product (GDP), and their relation with growth in GDP, and which incorporated the role of technical progress in the process of GDP growth. The rest of this chapter is arranged as follows:

Section 4-2 contains the studies using the C-D production function. Studies using the CES production function are reviewed in section 4-3. Section 4-4 discuss the empirical studies used both the C-D and the CES production functions. In section

4-5 the variables used in estimating the production function in this study will be described. Section 4-6 discuss technical progress and its impact on economic growth, while section 4-7 presents methods of measuring technological progress, the conclusion of this chapter is given in section 4-8.

4-2. Previous studies employing the Cobb-Douglas production function:

This review will begin by examining the work of Cobb and Douglas themselves as an introduction to the Cobb-Douglas production function. This function is designed to test neo-classical marginal productivity theory, in order to determine whether elasticities of output with respect to capital and labour corresponded to factor shares. Douglas observed that the output curve for the US manufacturing industry for the period 1899-1922 lay consistently between the two curves for the factors of production (Thirwall, 2006). Douglas and Cobb sought to develop a formula of function which could measure the relative effect of labour and capital on the growth of output over the above period. They took computed indexes, for American manufacturing, of the number of workers employed, as well as indexes of the amounts of fixed capital in industrial sectors in the USA (Douglas, 1948). The estimated function derived was as follows:

$$Y = 1.01K^{0,25}L^{0.75}$$

This result supported the neo-classical model of constant returns and marginal product pricing. There was no discussion of the relative importance of factors of production and the measurement of growth of output, until the work of Abramoviza and Solow (Thirwall, 2006).

Solow's study is one of the earliest which used the Cobb-Douglas production function. Solow (1957) applied the C-D production function by using non-agriculture data for the USA over the period 1919-1957. He attempted to isolate the shifts of aggregate production function from movement along the same function. The shift was an estimated increase in total factor productivity (TFP). He attributed this shift to technical progress (Solow, 1957). He also measured the growth rate of output for each factor by using the following form of equation:

$$g_Y = g_a + \alpha g_K$$

where g_Y, g_K and α are growth rate of output, capital stock for each factor and the share of capital stock in output respectively. The term g_a is equal to its marginal productivity of labour factor. Solow's result suggested that over the period of this study more than 87.5% of growth in output per man hour is attributed to an increase in total factor productivity (TFP), while the remaining 12.5% is a result of increases in capital per man hour. Solow showed that 80-90% of the growth of output per head in the US economy in the first half of the twentieth century could not be accounted for by increases in capital (Thirwall, 2006).

Ozyurt (2007) proposed a study to analyse the main source of economic growth in the Chinese industrial sector over the period 1952-2005. His study investigates empirically to what extent factor accumulation and total factor productivity (TFP) growth have contributed to output growth in the Chinese industrial sector. Ozyurt used the Cobb-Douglas production function, in order to estimate the relationship between y, which refers to industrial value added, and K and L, which are respectively capital and labour inputs. His methodology relied on the assumptions of neo-classical theory, such as perfect competition, constant returns to scale (CRS), production technology, and Hicks` neutral technological progress. All variables in his model were expressed in 1978 base year pricing. The form of function which he used was as follows:

$$Y_t = AtK^{\alpha}L^{\beta}$$

where t indicates time, α, β denotes output elasticities with respect to capital and labour respectively, A refers to technological change. The function was converted to a linear function, by taking the logarithm on both sides of the function, and it became:

$$\ln Y_t = \ln At + \alpha \ln K_t + \beta \ln L_t + \varepsilon_t$$

$$\ln Y = -0.02 + 0.82K_t + 0.18L_t$$

$t - value$ (-0.09) (19.0) (3.48)

$R^2 = 0.99$ $F = 3224$ $D - W = 1.9$

All the coefficients in his equation are statistically significant at a level of 1% except the constant term. The adjusted R-square is highly close to one, indicating a very good fit for the model. The F-statistics value means that all regressions are significant at 1%. The sum of the coefficients is equal to one; this result gives strong evidence for the existence of Constant Return to Scale (CRS) for production technology in the Chinese industry over the period of the study.

The elasticity of output with respect to capital is 0.82, whereas the elasticity of output with respect to labour is 0.18. In other words, the elasticity of the capital is more significant than other factors. Accordingly, Ozyurt (2007) considered that these results are in accordance with reality: low labour elasticity and high capital elasticity are major characteristics of transitional economies, where labour is abundant and capital is scarce. He inferred that the success of these countries has been driven by massive factor accumulation rather than innovative activities and technical progress (Ozyurt, 2007).

Chow and Wai Li (2002) applied the Cobb-Douglas production function using official Chinese data. Their study was an extension of one conducted by Gregory and Chow in 1993. A Cobb-Douglas production function was estimated for the Chinese economy over the period 1952-1998, excluding the years 1958-69. The extent of technical progress during the reform years equals zero from 1952 to 1977. It was equal to one in 1978, and increased by one each year. The Cobb-Douglas production function was estimated after taking natural logarithms of the both sides. The form of the function was as follows:

$$\ln GDP_t = \alpha_0 + \alpha_1 \ln K_t + \alpha_2 \ln L_t + \alpha_3 t$$

And under the assumption of constant returns

$$\ln(GDP/L)_t = \alpha_0 + \alpha_1 1\ln(K/L)_t + \alpha_2 t$$

This function was estimated by using least squares method under the assumption of constant return to scale. The elasticity of output with respect to capital and labour for the period 1952-1980, excluding 1958-69 are 0.63 and 0.35 respectively. Total factor productivity had zero growth from 1952-1978, and 0.03

from 1978-1998. The Chinese economy grew at a substantial rate of at least 7%, during this period because of the high rate of capital formation of over 30% of GDP, and the high capital elasticity of about 0.6.

Lezin (2005) aimed to investigate and analyze the impact of some production variables on agricultural productivity growth in China over the period 1989-2002, in order to explore whether labour, capital and land had an impact on agricultural production. Lezin argued that agricultural productivity growth was one of the main facets of the agriculture sector in the economic development in China, and that technology was the most important factor within this sector. The Cobb-Douglass production function was applied to analyze the impact of production variables on agricultural productivity growth for the period 1989-2002. The production function he used in the estimation process can be written as follows:

$$\log(GVAO) = \beta_0 + \beta_1 \log L + \beta_2 \log K + \beta_3 \log M + \varepsilon$$

Where $GVAO$ denotes the value of agricultural output, L is agricultural labour force, K is capital input, and M is agricultural land. The coefficients are the elasticity of β_i (i=1, 2, 3) variables with respect to agricultural production, with the assumption that $\beta_i > 0$. The results obtained are reported below:

$$\log(GVAO) = 60.35 + 0.97 \log L + 1.82 \log K + 0.17 \log M$$

t-value (3.47) (2.84) (4.18) (3.9)

$R^2=0.997$ $n=14$ $df = 10$ $\alpha = 5\%$

Where df is the degree of freedom.

Lezin concluded that the elasticity of agricultural output with respect to labour, capital and land were 0.97, 1.82 and 0.18 respectively. The elasticity of output with respect to capital was more significant than others factors. In his results, aggregating the three output elasticities obtained 2.979, which meant that in Zhejiang Province the agriculture sector was characterized by increasing returns to scale. R^2 is equal to 0.997 means that 99% of the variation in the log of agricultural output is explained by the log of labour, capital and land. The analysis shows that labour, capital and land are positively related to agricultural output, and all of the elasticities are statistically significant at the level of 5%. Lezin found that the total value of machinery in 1997 was more than three times that used in 1989, and the value of animals increased by 50% during the same period, which indicates that new technology became widely available.

Hu and Khan (1997) estimated the Cobb-Douglas production function of China's economy over the period 1953-94, in order to answer the question why the Chinese economy was growing so fast. The neo-classical model was used to analyze the source of Chinese economic reform, and to explain the acceleration of growth after economic reform. Before 1978 China had seen an annual growth of 6% a year, after 1978 China's economy saw average real growth of more than 9% a year and in several peak years the economy of China grew by more than 13 %. Why was this? Hu and Khan estimated the contribution of labour, capital and total factor productivity (TFP).

Hu and Khan (1997) found that capital accumulation played the most important role in economic development in the pre-reform period 1953-1978; its contribution in growth was 65 %, while the contribution of labour was 17%.

Even though labour input was an abundant resource in China, capital input was the most important contributor to growth in the pre-reform period. In the post-reform period 1979-1994 Chinese productivity increased at an annual rate of 3.9% during this period, compared with 1.1% during the pre-reform period, and by early 1990 the share of productivity as a proportion of output growth exceeded 50%, whereas the share of capital accumulation was below 33%. According to Hu and Khan (1997) the process of reform stimulated productivity growth in a number of ways, including the transfer of resources from agriculture to industry, a reallocation of resources from the public to the private sector, the encouragement of foreign direct investment and a faster growth of exports.

Massel (1960) used Solow's methods for estimating the growth of manufacturing sector in USA. His results show that 90% of the increase in output per man hour was created as a result of an increase in technical progress.

Nelson (1964) found that TFP growth was 2.1% per annum and thus explained more than 67% of the 3.1% growth rate of GNP for the USA. The remainder of the growth rate was due to the growth of capital and labour. This description indicates that TFP was a more important contributor to growth than labour and capital.

Bruton (1967) examined the sources of the growth of GDP in Five Latin American countries (LAC) over the period 1940-1964. The aim of his study was to compare these countries with more economically advanced ones[2]. Bruton used the

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[2] *The Latin American countries studied were Argentina, Brazil, Chile, Colombia, and Mexico. The advanced countries used for comparison included Belgium, Canada, France, Italy, Japan, the Netherlands, Norway, Sweden, the United Kingdom, the United States and West Germany.*

C-D production function, he found the lowest rate of productivity growth was in Argentina, where it was 0.5% of the growth of output, while the highest rate of productivity growth was in France during the same period, where it was 79%. In general he found that the productivity growth was lower in Latin American countries than in more advanced countries. Bruton argues that the lack of technology in Latin American countries can explain part of this difference in productivity growth.

Hall and Jones (1999) and Klenow and Andres (1997) showed that most of the variation in output per worker could be attributed to variation in TFP. Easterly and Levine (2001), Chanda and Dalgaard (2002) have shown that variation in TFP explain the difference in income per capita across countries.

4-3. Previous studies employing the Constant Elasticity of Substitution (CES) production function:

Alongside the C-D production function, another approach which has been extensively used as a tool to determine the source of economic growth is the CES production function. Sapir (1980) used the CES production function in order to examine the source of growth in manufacturing industry for the Yugoslavian economy over the period 1950-1974. The final form of production function which he used was the following:

$$\ln(Y/L) = \ln\gamma + \lambda t + \Omega Dt - \rho(\delta \ln(\frac{K}{L})^{-\rho} + 1 - \delta) + U$$

where

$\gamma =$ efficiency parameter.

$\delta =$ distributive parameter.

$\rho =$ substitution parameter.

$\lambda t =$ constant Hicks neutral technical change.

$\lambda t + \Omega =$ variable Hicks neutral technical progress.

$D =$ dummy variable, which takes the value 0 for the period 1955-1965 and 1 for the period 1966-74.

The CES production function was estimated for two periods, which were 1950-65 and 1966-74. Sapir found that the growth rate of manufacturing output in the Yugoslavian economy was 12.6% in the first period, while it fell to 7.6% over the second period. The growth rate of TFP was equal to 4.8% in his result, and the parameter of capital intensity was equal to 0.218, while the elasticity of substitution was equal to 0.319. Sapir found that the manufacturing industry in the Yugoslavian economy depended on labour more than capital, where the share of capital and labour to output was 21% and 38% respectively in the first period, and it was about 14% and 25% in the second period, whereas the contribution of TFP to output was 41% and 63% in the first and second periods respectively.

Saed (2002) applied the CES production function in order to estimate the rate of technical progress and capital-labour substitution to 16 companies in the Jordanian manufacturing industry over the period 1985-1997. The statistical model derived from Arrow, Chenery, Minhas and Solow's CES production function approach was adopted. The form of the equation, assuming perfect competition and constant returns to scale was as follows:

$$Y = [\delta K^{-\rho} + (1-\delta) L^{-\rho}]^{\frac{-1}{\rho}}$$

Where Y is the value added and it measures the output. L and K are the labour input and capital input respectively, ρ is the substitution parameter which determines the elasticity of substitution. Ordinary Least Squares (OLS) method was used to estimate the function for 16 companies, and the result was that the majority of these companies that the elasticity of substitution is positive in 13 of 16 companies, 6 of them have elasticities that are significantly different from zero at the 5% level; their value was less than one except for two companies, namely Chemical and Wood. Over the period 1985-1997, three companies (Chemical, Non-metal product and Petroleum) had negative rates of technical progress. The average rate of technical progress for the 16 groups was about 0.091.

Salem (2004) conducted an applied study in order to determine the best fit function for Tunisian data. The constant elasticity of substitution (CES) production function was estimated in his study over the period 1983-1994. He used statistical data for 14 sectors which produce tradable goods. The CES production function was estimated for each sector by using the non-linear least squares (NLS) method using GAMS software. The statistical data for the capital factor was expressed in millions of dinars (DM). Labour was expressed in thousands and output was expressed by added value, all of these values being expressed at the current and constant prices. He used the CES function to estimate the value-added of *td* activity, which used two factors of production (labour and capital). The form of function which he estimated was as follows:-

$$VA_{td} = A_{td} \left[\alpha_{td} K_{td}^{-\rho_{td}} + (1-\alpha_{td})) L_{td}^{-\rho_{TD}} \right]^{-1/\rho_{td}}$$

$$Avec = \rho_{td} = \frac{(1-\sigma_{td})}{\sigma_{td}}$$

Where *td* is sector and *VA* is the value-added of the sector, L_{td} and K_{td} are the labour and capital of the sectors respectively. A_{td}, α, ρ and σ are efficiency parameter, distribution parameter, substitution parameter and the elasticity of substitution respectively.

To facilitate the estimation of this function, Salem (2004) converted the non-linear function to a logarithmic form, which was represented in the following equation:-

$$\ln(VA_{td}) = \gamma - \frac{1}{\rho} * \ln(\alpha L_{td}{}^{-\rho} + (1-\alpha) K^{-\rho}{}_{td})$$

Where γ is the log of the parameter of efficiency. He stressed that the elasticity of substitution between the factors of production can be determined from the following equation:-

$$\sigma_{td} = \frac{1}{(1+\rho_{td})}$$

His result showed that the elasticity of substitution was close to one in most sectors, especially in the agricultural, fishing, clothing and leather sectors. This confirmed that the Cobb-Douglas production function must be adopted in many sectors in the Tunisian economy, with the exception of the oil and gas sectors and the transport and telecommunication sectors, which should take the CES form.

Dunne and Watson (2005) applied the CES production function, in order to examine the relationship between the impact of military expenditure and technical progress, and hence their impact on labour productivity and economic growth. They assumed that military spending affects economic growth through its impact on technical change trends. The CES production function was estimated over the period 1966-2002.

Dunne and Watson ignored using the Cobb-Douglas production function in their study, because it implies that elasticity of substitution is unitary and technical progress is neutral. Consequently, they used the general CES production function which took the following form:

$$Q = \gamma[s(K)^{-\rho} + (1-s)(Le^{\lambda t})^{-\rho}]^{-(v/\rho)}$$

where Q, K and L are defined as before, γ and s are production scale parameters. The elasticity of substitution was measured by the following function:

$$\sigma = 1/(1+\rho)$$

where technological progress is assumed to be labour augmenting at rate λ_t. Dunne and Watson (2005) found that the coefficients are consistent with expectations; there was a positive relationship between growth in output and growth of employment. The value of the elasticity of substitution was low and equal to 0.46, and there was some evidence of increasing returns to scale. Their results suggested that a 10% rise in the burden of military expenditure would eventually raise technical progress by 0.5%.

Antony (2007), introduced a new function with a dual elasticity of substitution between two factors of production. His idea built on normalizing the CES production function of De La Grandville (1989). To give support to his findings, Antony used data from the Penn world tables market; this data included an unbalanced panel of 64 countries over the period 1952-1992, the total of observations he used was 1673. To obtain an impression of the numbers of variables, Antony applied three regressions. The variables K,Y $\ln(K/K_0)$ and $\ln(Y/Y_0)$ are capital intensity, baseline production per efficiency unit of labour, natural logarithm of annual growth rate of the relative capital intensity, and the natural logarithm of growth rate of relative GDP per worker, and K_0 and Y_0 chosen values for the U.S, one regression contains the annual growth rate of capital intensity in the U.S because the U.S possesses the highest capital intensity. Antony produced a result which supports the hypotheses that the empirically observed difference in the elasticity of substitution between labour and capital has important implications for inequality across countries.

Antony (2007) found that capital intensity is growing faster in developed than in less developed countries. In other words, he found that the distinction between countries can be drawn with respect to human capital variables, so if this variable takes same value in all countries, the inequality between developed and less developed countries would disappear. Antony's result supports the finding of Arrow et al. in 1961, that the elasticity of substitution may change during the process of economic development. And it not must be equal to one as in the Cobb-Douglas production function, also the finding of Duffy and Papageorgion (2000) using a CES on a cross-section of 82 countries, found an elasticity of substitution (ES) greater than one for developed countries and less than one for developing countries. They suggest that the value of ES maybe be associated with the level of development in a country. If the (ES) between labour and capital is greater than one, a unique steady state exists and with the possibility of an endogenous growth rate (Barro and Sala-i-Martin, 1995). Change in ES will affect the growth rate of output, except when both production factors increase at the same rate (Kamien and Schwartz, 1968).

4-4. Previous studies employing both C-D and CES production functions:

In the existing literature some studies have also shown the relative importance of factor inputs and of technical progress based on neo-classical and endogenous growth theories, using both C-D & CES production functions. Whitesell (1985), who used both C-D and CES production functions to evaluate the hypothesis that the causes of Soviet economic decline reflect common factors present only in centrally planned economies.

Whitesell studied seven individual branches of industry for numbers of former Soviet Union, GDR, Poland, Hungary and Czechoslovakia. All these countries had very similar economic structure at the time. Whitesell applied two famous kinds of production functions, which were the C-D and CES production functions with variant and Constant Hicks neutral technical change. This application of these two functions was intended to discover which one of them was best suited to the data. Whitesell found that the growth rate of TFP was constant in Poland, GDR, and Yugoslavia, while it increased in Hungary.

However, the growth rate of TFP in the Soviet Union and Czechoslovakia was either constant or decreasing. Whitesell (1985) suggested that the cause for the difference in decline of the Soviet Union and the other countries was because that the

Eastern European countries depended on foreign trade much more than the Soviet Union. Finally, Whitesell (1985) states that the Cobb-Douglas production function with constant technical change and constant return to scale is a more suitable function for most Eastern European countries, with the exception of the Soviet economy.

Sadeg (1996) was concerned with a statistical analysis of Irish economic growth over the period 1951-1984; his study was a first attempt at an explanation of Irish economic growth along the lines proposed by neo-classical growth theory. A systematic analysis using a wide range of statistical test was employed in order to find the relative importance of factor input and of technical progress on Irish economic growth, and to measure the elasticity of substitution and return to scale. His study also set out to find an answer to a number of questions such as; what specification of the production function best fitted the Irish data? The Cobb-Douglas(C-D) and Constant Elasticity of Substitution (CES) production functions were both estimated in this study.

Sadeg found that the elasticity of substitution between the factors of production is equal to one. This confirmed that the C-D production function with variant Hicks neutral technical progress best fitted the Irish economic data. His result also showed that the rate of technical change was about 1.7% a year. The elasticity of output with respect to capital and labour input were estimated to be about 0.34 and 0.76 respectively. He also found that 59% of the growth rate of output was due to an increase in factor inputs.

Pereira (2002) estimated the elasticity of substitution for the Japanese economy over the period 1890-1998, and for the British economy over the period 1870-1991, and the American economy during the periods 1890-1992 and 1929-2000. The Constant Elasticity of Substitution (CES) and the Variable Elasticity of Substitution (VES) production functions were estimated in order to account for changes in the elasticity of substitution and capital intensity, and their relationship with technical change and economic growth. The VES production function included both the CES and the C-D production functions as special cases. Technical change was measured as Total Factor Productivity (TFP), and it was considered as the main source of economic growth.

The main results he found were that the elasticity of substitution was not unitary, and that it changed over time. When the CES production function was used to calculate the TFP to the three countries, Pereira found there was a variance of the TFP, and it was lower than the result obtained using the C-D production function. Using the TFP based on a Cobb-Douglas production function hid the role of the Elasticity of Substitution (ES) as a source of increase in output and also as a source of technical change.

Sahin (2003) claimed that although there were many studies concerning Turkish manufacturing industries, not one of these studies focused on choosing or determining the forms of production function which was more suitable for this sector. Two kinds of production function form were of interest in Sahin's paper, namely the Cobb-Douglas (C-D) and Constant Elasticity of Substitution (CES). He also investigated the change in growth rate of output in the manufacturing sector. The

Cobb-Douglas production function was estimated by the researcher. Sahin used data for the industry sector over the period 1980-1998. The form of function which he estimated was as follows:

$$Q = AL^{\alpha}K^{\beta}$$

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

He took a logarithm form for the function to be estimated easily, and the final form of the function which he estimated was as follows:

$$\ln Q = a_0 + a_1 \ln K + a_2 \ln L + u$$

where:

$$a_0 = \ln A \,, \quad \alpha = a_1 \quad \text{and} \quad a_3 = \beta$$

The Constant Elasticity of Substitution (CES) function was estimated in the following form:

$$Q = A[\delta K^{-\rho} + (1-\delta)L^{-\rho}]^{\frac{-\varepsilon}{\rho}}$$

Its logarithm form is:-

$$\ln Q = \ln A - (\frac{\varepsilon}{\rho})\ln[\delta K^{-\rho} + (1-\delta)L^{-\rho}]$$

The second term at the right side of this question, which is $f(\rho) = \ln[\delta K^{-\rho} + (1-\delta)L^{-\rho}]$ can be expanded around the value $\rho = 0$ to give a logarithmic approximation to the CES production function. Getting a second order approximation and adding an error term leads to the follow equations:-

$$\ln Q = a_0 + a_1 \ln K + a_2 \ln L + a_3[\ln(K/L)]^2 + u$$

where

$a_0 = \ln A$, $a_1 = \sum\delta$, $a_2 = \sum(1-\delta)$ and $a_3 = -(1/2)\rho\sum\delta(1-\delta)$

Sahin said that the Cobb-Douglas production function assumes that the elasticity of substitution between capital and labour is stable and equal to one. He also said if the estimated value of a_3 in the above equation is not different from zero, this means that the Cobb-Douglas production function will be adopted, and that furthermore, if $\rho = 0$, so the elasticity of substitution must be one and the production function is a Cobb-Douglas.

He also found that R^2= 0.85, which means that all production factor coefficients are significant and can explain 85% of a change. The ρ value is not different from zero for each year. This is implicit in the fact that the elasticity of substitution is equal to one. This confirms that the Cobb-Douglas production function form is more suitable for the Turkish industrial sector. Shahin found that manufacturing industries in Turkey depend on the labour factor more than capital accumulation and more than technical progress.

Kilponen and Viren (2008) estimated different specifications of the CES and C-D production functions. Their functions dealt with a time series of a group of large European countries (Germany and Italy) and a group of smaller countries (Ireland and Nordic countries), and the U.S. The two kinds of production functions for these countries were estimated over the period 1960-2004, in order to show the possible reasons for the growth differences in these countries. They concluded that R&D played the major role in separating between strong and weak growth across the countries. To obtain more definitive results, they estimated the C-D production function with and without R&D for two periods, 1960-2004, and the short period 1987-2004. The estimated equation reads simply as:

$$\log(Q_{it}) = a_0 + \alpha \log(L_{it}) + \beta \log(K_{it}) + \tau_t + \psi rd_{it} + \omega ts_{it} + \varphi pat_{it} + u_{it}$$

where $i = 1,....14(12)$ denotes country, $t = 1960,....2004$ denotes time trend, Q is private sector output (value-added), L is employment (number of employees), K is capital stock, rd is R&D intensity (business sector R&D expenditure/GDP), ts is a proxy for the openness of the economy (trade share), and finally pat is an indicator for the number of patents (several alternative measures are used).

First they estimated the equation and then used the estimated parameters as dependent variables in the regression models, these variables included t, rd, ts and pat. They also estimated the C-D production function with the assumption that elasticity of substitution can deviate from unity. This takes the following form:

$$\log(Q_{it} / L_{it}) = b_0 + b1 \log(w_{it}) + b_2 t + b_3 rd_{it} + b_4 tt_{it} + b_5 pat_{it} + e_{it}$$

Kilponen and Viren (2008) found a strong positive relationship between both the level of R&D and labour productivity, and between labour productivity and real wages. The shares of labour and capital were 0.6 and 0.4 respectively. The R&D variable had a significant coefficient, it was equal to 0.1. It also has a reasonably large coefficient and a high ratio, and this did not surprise them because of the previous empirical evidence on the role of R&D (Jones and Williams, 1998). They also estimated the CES production function which is written as

$$Q_{it} = A(\alpha(L_{it}e^{\pi t})^{-\rho} + (1-\alpha)K_{it}^{-\rho})^{\frac{-\theta}{\rho}}$$

where $\rho = p_0 - p\Delta_t$ and A is the shift factor for the production function. Parameter $\rho\Delta_t$ captures the trend-like behaviour in the elasticity of substitution, α is the share parameter and θ is the scale parameter.

And the result was, although the estimated elasticity of substitution increased over time, it was still lower than one.

Minh and Long (2008) used the Cobb-Douglas and Constant Elasticity of Substitution functions in order to show whether technological change and/or technical efficiency accompanied productivity growth in the Vietnamese economy. They analysed the change in productivity during the period 1985-2006 through using the two functions. They used these two functions to determinate the contributions of labour, capital and technical change to economic growth over the time. The final forms of the two production functions they used to analyse productivity growth were as follows:

The Cobb-Douglas form was:

$$\ln GDP_t = \alpha_0 + \alpha_1 \ln L_t + \alpha_2 \ln K_t + V_t - U_t$$

While the CES form was:

$$\ln GDP_t = \alpha_0 + \alpha_1 \ln L_t + \alpha_2 \ln K + \beta(\ln K_t - \ln L_t)^2 \quad + V_t - U_t$$

Where GDP, K and L are output, capital and number of workers respectively, α and β estimated parameters and V and U are error terms. To test the hypothesis that the C-D and CES production functions are the same, Minh and Long (2008) stated that their aim was to determine whether the Cobb-Douglas or the CES form was most appropriate to the Vietnamese economy. This relied on a value of β, if $\beta = 0$, the production function would follow the Cobb-Douglas form. The hypothesis was rejected, and the CES form of production function to both the whole and the individual sector was estimated. They found that the growth of total productivity was largely driven by capital and labour, and partly by technological progress. The percentage of capital and labour to the growth rate of TFP were 45.8% and 34.5% respectively, while 19.7% was due to technological progress. Minh and Long (2008) also found that the productivity growth rates of the industrial and agriculture sectors were 6.3% and 1.6% respectively, while there was a fall of -4.7% in the services sector, they explained these drivers in the growth rates by a variety of factors, especially to the quality of labour attributed to educational level in each sector.

There have been some studies in different parts of the world in both developing and developed countries which concern the agriculture sector. Al Najafi and Hussain (1993) estimated the production function in Iraq's agricultural sector during the period 1970-1986.The variables included in their study were output (dependent variable), land, labour and capital (as independent variable). The figure for land was an index of total cropped area, and capital included value of seeds, fertilizers, irrigation charges, electricity, pesticides, maintenance and other operational expenditure. A log–linear model was used and the estimated results were as follows:

$$\log Y / AC = 1.84 + 1.04 \log X_1 + 0.012 \log X_2 / AC + 0.51 \log X_3 / AC$$

$s.e$ 4.74 0.62 0.48 0.091

$t-value$ (-0.39) (1.96) (0.03) (5.58)

$DW = 1.25$ $\qquad\qquad R^2 = 0.82$

Where Y =gross annual value of agricultural output, X_1 =index of total cropped area, X_2 =labour force in agricultural in thousands, X_3 =annual capital expenditure and AC =area under crops, in thousand donums.

Echevarria (1998) estimated value added in the agricultural sector as a constant return to scale function of three factors of production, which were labour, capital and land, using the Cobb-Douglas production function over the period 1971-1991. He estimated the function for three sectors which were industry, agriculture and service sectors. Although, the contribution of land was negligible in the industry and services sectors, he stressed that there was no harm in equating land to capital in these two sectors.

However, this was not the case with agriculture. Echevarria used Canadian data, and his result was that the shares of labour, capital and land in value added were 41%, 43% and 16% respectively. He found that the contribution of labour in Canadian agriculture was less than in both the service and industry sectors, compared with his previous estimation for these sectors in 1997. The shares of capital and labour respectively were 41% and 59% in industry and 49% and 51% in services. Capital intensity was similar in these sectors. The rate of technological change was similar in those sectors and its value was 0.3%.

Previous studies generated mixed results. Existing models of economic growth, be it the neoclassical school or "new" growth theories, are mainly concerned with economic growth in the long run or the shift of the production possibility frontier. However, the question of economic growth in transitional economics like Libya is about movements towards the frontier, as well as shifts of the frontier. It is possible to borrow a model from the stochastic frontier literature to accommodate the two types of economic growth.

4-5. Variables used in estimating the production function:

Through the presentation of the production functions and the studies which have applied them in both developed and developing countries, it has been found that these studies used the same form of production function, and through the study of those function formulas, it was noted that they used labour and capital inputs as essential factors. Production is also influenced by many other factors, and it is not always clear whether economic factors could fully deal with their analysis and measurement; some factors are not easily analysed or measured, for example, agricultural production is affected by natural and climatic factors, such as rain, temperature and humidity, as well as the spread of diseases that may affect plants and animals. Many other factors have been ruled out of studies, such as raw materials for the manufacturing sector and areas planted for the agricultural sector, which have a proportionate impact on the level of production in these sectors.

This study focuses on three fundamental quantity factors which are capital, labour and technical change, in order to facilitate the econometric analysis process which is required, and then to identify the causal relationship between endogenous and exogenous variables which explain economic changes.

4-5-1. Gross Domestic Product (GDP):

GDP is the total market value of goods and services produced by a national economy in one year. It is usually used as a dependent variable (Q) when estimating the production function. The classification used for economic activities in Libya is the same as adopted by the United Nations. These economic activities are divided into ten major sectors, namely: agriculture, forestry and fishing; manufacturing; quarrying; electricity, gas and water; construction; trade, restaurants and hotels; transport, storage and transportation; finance, insurance and property; home ownership; and public services (Salem and Schiller, 2001).

The agriculture and manufacturing sectors have been chosen because they are the most important sectors in terms of development plans. The share of GDP of these sectors is a dependent variable in this study because it gives a better indicator of economic growth. Real GDP is used in both sectors to express this variable, which is calculated by dividing GDP at current prices by price indexes or by a deflator, in order to exclude any defects produced by inflation problems. This study used the production value rather than the quantity of production due to a lack of homogeneity of goods produced in these sectors. The source of the data was the publications of the General People's Committee of Planning and the Central Bank of Libya. The measure of output chosen in this study for carrying out a growth accounting exercise for the Libyan economy was GDP at factor cost and at 1980 prices. The figures relating to aggregate output represented by GDP are presented in table 8 in the appendices.

4-5-2. Capital input (K_t):

Previous studies (e.g. Solow, 1957, Ozyurt, 2007), stress that the capital factor is one of the most important factors that has an impact on the production value and then on the economic growth of any country. Thus, in this study, the researcher assumed that changes in agricultural output and in industrial output in Libya depend on the change in capital input to a greater extent than the change in any other production input.

Henry (1989) employed the perpetual inventory method in constructing his capital stock estimate. This methodology of calculating capital stock was pioneered by Goldsmith and Sanders in 1959 (as cited in Keeney, 2006), and is an accumulation of the past capital formation mathematically expressed as follows:

$$K_t = I_t + (1-c)K_{t-1} \tag{4-1}$$

Where:

K_t = fixed capital stock value by the end of period t.

I_t = fixed capital formation in the period t.

c = depreciation rate of capital.

K_{t-1} = capital stock value of the previous year.

There are also other ways to estimate the value of fixed capital stock including:-

$$K_t = I_t + hK_{t-1} \tag{4-2}$$

where K_t, K_{t-1} and I_t were defined previously.

h represents the growth rate of fixed capital stock.

There are also studies which use the rate of capital productivity (ICOR), which can be calculated as follows (Thirwall, 2006):

$$ICOR = \frac{\text{Investment in year } t}{\text{Change in the output value in the year } t}$$

The relationship between capital and output is embodied in the concept of the capital ratio, which can measure in physical units, or in value terms, either the average or the marginal relation between capital and output. The average capital-output ratio of an economy is the stock of capital divided by the annual flow of output (K/Q), while the marginal or incremental capital-output ratio ($ICOR$) measures the relationship between increments to the capital stock and increases in output ($\Delta K/\Delta Q$) or ($I/\Delta Q$) (Thirlwall, 2006. p.212).

However, fixed capital stock value in this study will be calculated according to equation 4-1 because it is the most commonly used according to previous studies (e.g. Solow, 1957, Ozyurt, 2007). The direction of this factor would be as follows:-

$$\frac{\Delta Q}{\Delta K_t} > 0$$

4-5-3. Labour input (L_t):

The labour input can be expressed in three ways, which are: number of used working hours (man-hours) in the production process, the value spent on working hours (wages), and the number of workers. According to Klein (1965) and others, a series of man-hours is a suitable way to measure labour input. However, this argument has been criticised on the grounds that labour input is not homogenous, neither within firms nor across industries or over years. The measurement of labour using man-hours is not satisfactory, as pointed out by Nadiri (1970), if perfect competition is assumed to exist, the factors of production would pay their marginal productivity, and then wages could be used to represent labour.

The preferred way to represent labour input in this study is by relying on the number of workers as a quantitative variable, not only because it is the most commonly used method in estimating production functions, but also because it reduces the problem of multi-linear correlation when estimating the function parameters, and because the lack of data on working hours and of wages in the Libyan database. Production quantity is proportionately correlated with employment, but it is possible to apply the law of diminishing returns in this case, because an increase in production costs resulting from an increase in the number of workers leads to reduced production in the productive sectors, rather than increased.

$$\frac{\Delta Q}{\Delta L} \supseteq 0$$

4-5-4. Other variables:

In addition to the factors mentioned above, there are other factors which may affect the growth rate of production in the Libyan productive sectors; among these factors are: climatic and natural factors, such as temperature, humidity, and also diseases and pests that may affect agricultural products; in addition, administrative and structural factors affect both sectors (agriculture and manufacturing). Also political factors have a negative or positive impact on production, among these factors is: the economic embargo imposed on the export of oil during the period 1973-1974 as a result of the Arab-Israeli war. The Iranian crises also caused an increase in world oil prices leading to an increase in oil revenues for all the oil producing countries, and Libya was no exception. This had an impact on the productive sector.

In 1982 world oil prices decreased sharply, this was due to a world recession. This decrease in oil prices caused Libyan oil revenue to decrease, and this problem was deeply harmful to Libya because 40% of Libyan oil was exported to the USA (EI-Fituri, 1992). This also affected the growth rate of output in the productive sector. In addition to the above factors was the economic blocked imposed on Libya during the period 1992-2002. There was economic openness during the period 2002-2008 coincided with some major structural and administrative changes in the country, also coincided with a surge in oil prices as well as increased quotas of oil export, such that the quantity of oil exported rose from 0.9 million barrels a day in 2002 to 1.4 million barrels a day in 2008 (LCB, 2010). All of these factors mentioned above led to significant changes in economic growth. Most of these factors may have decreased the productivity of these sectors, and to include them in the production functions for these sectors, a dummy variable was developed, which takes a value of one in the case of these factors and a value of zero in the case of their non-existence.

Additional to these factors are also structural changes which occurred in the agricultural sector during the period 1993 to 1996. This period saw the application of a three-year programme aimed at staging the liquidation of obligations on development projects and classifying them into essential and non-essential projects. The essential projects had to be implemented and non-essential ones were either cancelled or converted to private sector activity. This followed the introduction of Law 9 (1992) and its implementing regulations, which resulted in a significant decrease in actual expenditures of the development budget in the agricultural sector, which resulted in a decrease in domestic agricultural output over the above mentioned period.

4-6. Technical progress and its impact on economic growth:

Technical progress is any change in the production function which makes it possible to produce more output by using the same quantity of inputs, or that means that the same amount of output can be produced by employing smaller quantities of one or more inputs (Thirlwall, 2006). It may be defined as a shift in the production function, while accumulation of factors is identified with a movement along the function. Technical progress is knowledge and it is the core of economic growth. It is an umbrella term to cover all factors which contribute to the growth of total productivity (Thirlwall, 2006). Kennedy and Thirlwall (1972) cite Tinbergen, who in 1942 was the first to explicitly estimate technical progress as a separate item in the aggregate production function in the case of the C-D production function, using an exponential time trend.

Economic growth theories do not fit all the facts so far. They say that GDP, labour and capital must grow to achieve growth in the economy. It is true that capital and GDP do not grow at the same rate. However, they grow more rapidly than labour, the reason for which may lie in technical progress. Solow in 1950 introduced a mathematical model, which showed the contribution of various factors to national economic growth. He stressed that technical progress supports economic growth more than labour and capital accumulations. Solow's studies helped the US government to redirect their investment to technological research and development in order to improve economic growth (Crafts, 2008).

Classical economists ignored the role of technology and its impact on economic growth. They stated that technical progress may postpone economic recession, but not indefinitely. The club of Rome model also doubted the ability of technical progress to achieve growth.

Harrod in 1948 and Hicks in 1932, (as cited in Thirlwall, 2006) employ the concept of the capital-output ratio, given the rate of profit, to classify technical change as capital-saving if it lowers the capital-output ratio, and as labour- saving if it raises the capital-output ratio, and as neutral if it leaves the capital-output ratio unchanged. According to neo-classical and endogenous theories, technical progress had a vital role in influencing the productivity of input factors. Solow (1957) described technical progress as exogenous. However, Romer (1990), Parente and Prescott (1994) and Barrow and Sala-i-Martin (1995), Eaton and Kortum (1996) described it as endogenous. It was believed that there were no diminishing returns to capital, especially when capital includes human capital, because of technology. The assumption that poor countries would grow faster than rich ones, and that per capita income across the world would converge, would disappear. Loo and Soete, (1999) cite Arrow, who in 1962 indigenized technology by assuming learning by doing, stated that technical progress grew at a constant rate, and found that long-run economic growth crucially depends on population growth.

There are two kinds of technology, i.e. neutral and non-neutral. Neutral technology is expressed through change in the degree of return to scale, and change in technology efficiency (Hall and Jones, 1999). It is change in production resulting from the change in production factors. With neutral technical progress the production function shifts such that the new point of tangency at the same factor-price ratio lies on the same expansion path. This means that the ratio of marginal products has the same capital-labour ratio and equal proportionate amounts of the two factors are saved. The condition for neutral technical progress is simply that the new production function is parallel to the old.

However, non-neutral technology is that which affects one of the production factors, whether labour or capital. This kind of technology reflects that technical change is capital or labour intensive: an increase in capital intensity because of new investment would result in an increase in total productivity. With non-neutral technical progress, the ratio of the marginal product of capital to the marginal product of labour rises in the case of labour-saving technical change, such as a shift in the minimum-cost point of tangency from the old expansion path. However, in the case of capital-saving technical progress, the marginal product of labour to the marginal product of capital rises and the shift in the production function is such that the minimum-cost point of tangency now lies to the right of the old expansion path (Thirlwall, 2006, p.219).

4-7. Measuring technological progress methods:

Technical progress has been discussed as an indispensable source of economic growth, and the literature on technical progress was surveyed by Solow (1957). There are two approaches to measuring the effect of technical change on economic growth. These approaches are the indirect or non-parameter method and direct or parameter method (Mongia and Sathaye, 1998). The direct method, unlike the indirect, assumes that technical change is one of the production factors, and it may take a variable value. In other words, the rate of technical change in this case is assumed to be a variable. Solow (1957) and Kendrick (1961), used the non-direct method; they assumed that rate of technical change is constant. Solow (1957) in his well-known pioneering paper derived and estimated the neutral rate of technical change through a two-factor aggregate production function. Solow assumed that technical change is Hicks neutral, which does not change the marginal rate of substitution of capital for labour into a constant capital-labour ratio. He also assumed full competitive markets of production factors; meaning factors are paid their marginal product (Bessen, 2008).

The two approaches of measuring technical progress will be discussed in more detail. This section deals with the indirect approach, which implies three indices for measuring technical progress, i.e. Solow's, Wan's and Kendrick's methods. The second approach, i.e. the direct approach, will also be discussed in more detail in section 4-7-4.

4-7-1. *Solow's method:*

Solow (1957) considered a standard neoclassical production function with constant returns to scale, in order to isolate change in output per head due to technical change. Solow said that if Q represents output and K and L are production factors which are capital stock and labour respectively, and they are measured as physical units, the aggregate production function would be written as follows:

$$Q = f(K, L, t) \tag{4-4}$$

The variable t for time appears in f to allow for technical change.

Solow used technical change as a short hand expression for any kind of shift in the production function, such as improvement in the education of the labour force. He assumed that technical change is Hicks neutral. Thus, the production function would take the following special case:

$$Q = A(t) f(K, L) \tag{4-5}$$

where A is a term representing the unknown residual "technical progress" at time t, and the multiplicative factor $A(t)$ measures the cumulated effect of shifts over time.

Differentiating both sides of equation 4-5 with respect to time and dividing them by Q would obtain the following form:

$$\frac{\dot{Q}}{Q} = \frac{\dot{A}}{A} + A\frac{\partial Q}{\partial K}\frac{\dot{K}}{Q} + A\frac{\partial Q}{\partial L}\frac{\dot{L}}{Q} \tag{4-6}$$

where the asterisks indicate time derivatives.

According to the assumptions of neo-classical theory (Hicks neutral technical change, competitive equilibrium, constant returns to scale and factor rewards being determined by marginal product) the factor inputs are paid their marginal product, this means that:

$$r_K = \frac{\partial Q}{\partial K}\frac{K}{Q} \qquad \text{and} \qquad w_L = \frac{\partial Q}{\partial L}\frac{L}{Q}$$

where r_K and w_L are prices of capital and labour respectively. Substituting them in equation 4-6 the result would be as follows:

$$\frac{\dot{Q}}{Q} = \frac{\dot{A}}{A} + r_K\frac{\dot{K}}{K} + w_L\frac{\dot{L}}{L} \tag{4-7}$$

where $\dot{Q} = \frac{\Delta Q}{Q} = r_Q$, $\dot{A} = \frac{\Delta A}{A} = r_T$, $\dot{K} = \frac{\Delta K}{K} = r_K$ and $\dot{L} = \frac{\Delta L}{L} = r_L$

Thus, equation 4-7 will take the following form:

$$r_Q = r_T - \alpha r_K - \beta r_L \tag{4-8}$$

where r_Q is the rate of change in output per time period because of technical progress, r_T is the annual rate of growth of total productivity of factors, or technical progress,

r_K is the annual rate of growth of capital, r_L is the annual rate of growth of labour, and α and β are the partial elasticity of output with respect to capital and labour respectively, and they represent the shares of production factors in output.

Technical change rate can be calculated from equation 4-8 as follows:

$$r_T = r_Q - \alpha r_K + \beta r_L \qquad (4\text{-}9)$$

4-7-2. *Wan's method:*

Wan (1995) presented a new non-parametric approach to calculate the rate of total factor productivity (TFP) growth. Wan claimed that the traditional approaches of growth accounting, such as Solow (1957), depend on certain assumptions, such as profit maximization and perfect competition, which may be inappropriate for some centrally planned economies. He ignored some of these limiting assumptions in his approach. His method to estimate the rate of technical change was derived from the definition of added values; added value is equal to the sum of the amount of production factors which are weighted by their prices.

Wan (1995) assumed production function in the case of two factors, which are labour (L) and capital stock (K).. The production function was proposed as follows:

$$Q_t = f_t(L_t, K_t) \qquad (4\text{-}10)$$

There was no explicit reference to time in the above equation, Wan assumed constant technological return to scale. Wan said that technical change occurs when functional form changes. This means that $f_1 \neq f_{t+1}$. According to Wan's approach, technical change affects the form of a function, or its parametric, or both. However, in the traditional approach, technical change is only reflected in varying parametric values of a production function.

Wan's method depends on the fact that technical change enables firms to produce the same amount of output with fewer (cost) factor inputs. Optimal production will be achieved. Mathematically when the curve slant of production is equal to the curve slant of cost function, this means:

$$Y_0 = TC_0 = w_0 L_0 + r_0 K_0 \tag{4-11}$$

where 0 represents base year and Y_0, TC_0, L_0, K_0, w_0 and r_0 are output, total cost, labour, capital stock, wages and profits respectively, and all are measured in real values. Wan claimed that when technical change occurred, either the amount of production factors would increase or their prices would decline, then the production function changes. The new production function would be written as follows:

$$Y_1 = TC_1 = w_1 L_1 + r_1 K_1 \tag{4-12}$$

Wan said that technical change (TE) is the difference between the cost of producing Y_2 using the same technology used to produce Y_0 , and the cost of producing Y_1 using different technology, but with the base prices of production factors.

Where Y_2 is another production function, its form changes because of technical change. Thus:

$$TE = (w_0 L_2 + r_0 K_2) - (w_0 L_1 + r_0 K_1) \quad (4\text{-}13)$$

Consequently, according to Wan the rate of technical change is the saving in cost resulting from using fewer factor inputs. Assuming that:

$L_2 = \gamma L_0$ and $K_2 = \gamma K_0$

Where γ is constant value and assuming a constant return to scale, Wan said that:

$$Y_2 = \gamma Y_0$$

Rearranging equation 4-13 gives:-

$$TE = (w_0 \gamma L_0 + r_0 \gamma K_0) - (w_0 L_1 + r_0 K_1) \quad (4\text{-}14)$$

Wan said that the rate of technical change or growth of total factor productivity is equal to TE divided by Y_1, thus:

$$TE / Y_1 = [(w_0 \gamma L_O + r_0 \gamma K_0) - (w_0 L_1 + r_0 K_1)] / (w_1 L_1 + r_1 K_1)$$

From definition:

$\gamma = Y_2 / Y_0$ and $Y_2 = Y_1$

Thus:

$$T/_{Y_1} = \frac{(Y_1/_{Y_0})(w_0 L_0 + r_0 K_0) - (w_0 L_1 + r_0 K_1)}{(w_1 L_1 + r_1 K_1)} \quad (4\text{-}15)$$

Wan used equation 4-15 to measure the rate of technical change, he comparing his result with those obtained applying Solow's method. Wan concluded that the results were very similar.

4-7-3. Kendrick's method:

Kendrick`s method of measuring technical change is based on the comparison between the input and output of the production function (Kendrick, 1961). Production factors are often measured by their contribution to national income, and where a fully competitive market is assumed, so the production factors will be measured at their cost. The income function would be written as follows:-

$$Q = wL + rK \tag{4-16}$$

where Q is output, w is wages, r is profit, and L and K are labour and capital respectively. Assuming that wages and profit are constant, the change will happen in production factors. Therefore, we can obtain the rate of growth from the following function:

$$\frac{Q_1}{Q_0} = w_0\frac{L_1}{L_0} + r_0\frac{K_1}{K_0} \tag{4-17}$$

where $L_1 = \Delta L$ and $K_1 = \Delta K$

Usually growth in production is greater than the contribution of production factors in the production process. The difference is due to technical change and this requires the addition of another factor to the function, which is T. Thus the final form of the equation would be as follows:-

$$\frac{Q_1}{Q_0} = T_0 [w_0 \frac{L_1}{L_0} + r_0 \frac{K_1}{K_0} \ ] \qquad (4\text{-}18)$$

This equation could be rewritten as follows:

$$T_0 = \frac{\frac{Q_1}{Q_0}}{w_0 \frac{L_1}{L_0} + r_0 \frac{K_1}{K_0}} \qquad (4\text{-}19)$$

where T is the rate of technical change.

The rate of technical change in the case of the CES production function is calculated as follows:

$$T_0 = \frac{\frac{Q_1}{Q_0}}{\left[\delta\left[\frac{K_1}{K_0}\right]^{-\rho} + (1-\delta)\left[\frac{L_1}{L_0}\right]^{-\rho}\right]^{-1/\rho}} \qquad (4\text{-}20)$$

And in the case of the Cobb-Douglas production function is calculated as follows:-

$$T_0 = \frac{Q_1}{Q_0} / (\beta_1 \frac{K_1}{K_0} + \beta_2 \frac{L_1}{L_0}) \qquad (4\text{-}21)$$

4-7-4. *Direct method measuring of the growth rate of technical change:*

The growth rate of neutral technical change is estimated directly in this approach. The time trend is included as an explanatory variable in the two types of production functions (C-D and CES). There are two alternative specifications of technical change, outlined as follows:

$e^{\lambda t}$ refers to constant growth of technical change .i.e. Constant Hicks neutral technical progress. "Technical change takes place at constant rate λ , it is assumed to be disembodied and Hicks neutral, so that when there is a shift in the production function K/L ratio remains unchanged at constant prices" (Mongia and Sathaye, 1998. p. 9). $e^{\lambda t+\lambda t^2}$ refers to variable and continuous growth of technical change. i.e. variable Hicks neutral technical progress.

If the two kind of technical change are included to the C-D and CES production function, the following forms would be obtained:-

-Cobb-Douglas production function with constant growth of technical change. (Constant Hicks neutral technical progress):

$$Q = Ae^{\lambda t}K^{\alpha}L^{1-\alpha} \tag{4-22}$$

- Cobb-Douglas production function with variable and continuous growth of technical change (Variable Hicks neutral technical progress):-

$$Q = Ae^{\lambda t+\lambda t^2}K^{\alpha}L^{1-\alpha} \tag{4-23}$$

- Constant Elasticity of Substitution with constant growth of technical change (Constant Hicks neutral technical progress):-

$$Q = Ae^{\lambda t}[\delta K^{-\rho} + (1-\delta)L^{-\rho}]^{\frac{-\omega}{\rho}} \tag{4-24}$$

- Constant Elasticity of Substitution with the variable and continuous growth rate of technical change (Variable Hicks neutral technical progress):-

$$Q = Ae^{\lambda t+\lambda t^2}[\delta K^{-\rho} + (1-\delta)L^{-\rho}]^{\frac{-\omega}{\rho}} \tag{4-25}$$

The direct approach to measuring the growth rate of technical progress will be adopted in this study.

4-8. Conclusion:

Economic growth theories were reviewed in the second chapter, and some empirical studies have been reviewed in this chapter, especially those which focus on the contribution of these theories to an understanding of economic growth. It is obvious that these theories identify the important factors of growth; capital accumulation includes human capital, labour and technical progress.

A review of the variables used in the estimation process took place in this chapter with a special review of the different ways which can be used to measure them. Specific studies concerning developing countries are few and they differ due to the varying motivations for their investigations. This chapter was dedicated to a review of some of these previous studies, particularly those based on the same tools that are used in this study.

Two distinct approaches for measuring technical change were also reviewed, the parametric approach within which three indices were constructed, i.e. Solow, Wan and Kendrick indices, and within the non-parametric approach three specifications were also given to technological change: constant, variable and continuous, and variable and discrete.

Consequently, we can identify the factors that affect Libyan economic growth from a variety of perspectives. The empirical studies part of this chapter showed how production functions can analyse economic growth. However, there is a clear absence of analysis in the literature of Libyan research.

CHAPTER FIVE

Theoretical framework for the model equations in the Libyan economy

5-1. Introduction:

Economic growth has been studied for decades by economists, and this dissertation aims to present an analytical review of the role played by production factors, i.e. capital and labour, and by technical progress in the economic growth of the Libyan non-oil productive sectors during the period 1970-2008. Several econometric models have emerged to study the determinants of economic growth. These models are drawn from previous studies have been applied in different parts of the world, among these studies are the study of Green Wood, Hercowitz and Krusell in (1997), who built their findings on the utilization of the Cobb-Douglas production function which was advocated by neo-classical theory, which assumes increases in production factors (labour and capital) through technology at a steady rate could eventually lead to an increase in production at the same rate. They concluded that technological progress contributed to the growth of the U.S. economy by 58% through investment.

Barro and Sala-i- Martin (1995), and Jones (2003) state that steady changes in the labour factor through technology lead to economic growth in the long run. This impression of the impact of technological progress on economic growth is developed from the arguments of Solow (1956), Romer (1990) and Aghion and Howit (1992, 1998). Neo-classical theory maintains to achieve balanced growth the production function should be connected with changes in labour factor and technological progress.

Hicks (1936) argued that the process of technological development in the long run must start from the labour input. Hicks (1932) explained that improvements in capital lead to a relative decline in the price of capital and the change of this relative price could eventually lead to a decline in total costs, as well as an increase of in the price of another factor, which is labour; that is why he maintained that it is necessary for improvements in labour to be more than in capital in the long run.

It has been accepted by economists that elasticity of substitution between labour and capital determine the impact of technological progress on economic growth. If elasticity of substitution is equal to one, the production function must be a Cobb-Douglas production function, if the elasticity of substitution is not equal to one, the investment in production factors will not lead to economic growth at fixed rates, the reason being that the changes (improvements) must be in labour in the long run.

The elasticity of substitution between the production factors in the case of the Cobb-Douglas production function is equal to one. Thus capital contribution is equal to one-third; the contribution of labour must be equal to two-thirds. However, if the elasticity of substitution is not equal to one, capital contribution will either be zero or infinity, depending on the value of elasticity of substitution. If it is less than one, there will be a decline in the relative prices of production factors (capital and labour) greater than the relative increase in the ratio of capital to labour. Thus the relative contribution of capital would become zero (Jalava et al., 2005). This is because that capital factor becomes more abundant and there is no way for a substitution between labour and capital: in this case, the labour factor would be more important for production and therefore wages would rise.

On the other hand, it can be said that when the elasticity of substitution between the production factors is greater than one, it is easy to replace the capital instead of the labour factor, and the contribution of the labour factor would shrink to zero and hence this would lead to an infinite contribution by the capital factor (Ledesma, et al., 2010). Greenwood, Hercowitz, and Krusell (1997) stated that technological advances support economic growth in the long run. On the other hand, Acemoglu (2003) wrote that changes in capital lead to temporary growth, but in the long run economic growth results from development in the labour factor).

This discrepancy reflects the adoption of different production functions. The CES production function nests the Cobb-Douglas function when elasticity of substitution between production factors tends toward one $(\sigma = 1)$. The Cobb-Douglas production function has two characteristic features: the contribution of capital and labour are fixed, and the elasticity of substitution between capital and labour is equal to one. The question is, whether it is possible to apply these properties in an actual economy. Ledesma, et al (2010, p. 9) stated that:

> *When the elasticity of substitution is equal to one, an increase in technology does not produce a bias towards either factor (factor shares will always be constant since any change in factor proportions will be offset by a change in factor prices.*

Thus the question of whether the value of elasticity of substitution between production factors is unitary remains debatable.

This chapter presents econometric models for investigating the long-run relationships between the input factors and output in the Libyan agricultural and manufacturing sectors. The rest of this chapter is divided into seven sections, including those that explain procedures and methods used to analyse production functions in order to determine factors affecting economic growth.

5-2. Matching a production function to the Libyan economy:

The choice of the form of production function is based on the assessment and characteristics of the relationship between production and its factors. For example, testing the linear production function that $Q = a_0 + a_1 L + a_2 K$, where α_0 is the constant, a_1 represents a marginal product of labour MP_L, and a_2 represents the marginal product of capital MP_K, there is an implicit assumption that each of the marginal products of labour and capital is constant. The linear function is characterized by access to production without labour or capital, and it is also non-homogeneous because of the presence of a_0. But if a_0 is ruled out, the production function becomes a homogeneous of the first degree, which means that a change in both production factors by a certain amount would lead to a change in production (Q) by the same amount. Thus, the choice of linear function as a framework for the estimating process to determinate relations between production and its factors has clear limitations from the beginning, and for this reason this study has focused on non-linear production functions.

The Cobb-Douglas production function has been the most commonly used in both theoretical and empirical analysis for long time. However, a strict restriction implied by the Cobb-Douglas production function is that it assumes the elasticity of substitution between factors of production to be equal to one. Many scholars have applied Cobb- Douglas production function using data from various parts of the world, and it have been found that if the elasticity of substitution is allowed to vary freely rather than being constrained to being equal to one, the C-D production function is better fitted to historical data (Willman, 2002).

Therefore, some economists, such as Arrow, Chinery, Minhas and Solow (1961) who argue that the assumption that the unilateral elasticity of substitution in the Cobb- Douglas production function is not feasible in applied studies, for this reason they prefer to use the CES production function.

This study is concerned with two kinds of production function forms, namely CD and CES production functions, in order to identify a suitable production function for the Libyan economy. The study also seeks to discover the relative importance of production factors and of technical progress, and their impact on economic growth in the productive sectors, assuming that production in the agriculture and manufacturing sectors depends on three essential factors, namely labour, capital and technical change. In this study, the Cobb-Douglas production function will be estimated in the following form:

$$Q = AK^{\alpha} L^{\beta} u \qquad (5\text{-}1)$$

where Q, K and L are production, capital and labour respectively, α and β are the output elasticity with respect to capital and labour respectively, A is efficiency parameter (equivalent to Total Factor Productivity (TFP) in the Solow model), u is a multiplicative error term with $Eu = 0$ and $Eu^2 = \sigma^0$. The Cobb-Douglas production function has been the most commonly used in the history of econometrics.

> *There are many reasons behind this popularity. In addition to its analytical simplicity, the Cobb-Douglas function has many attractive properties (e.g. concavity, homogeneity and aggregation) and it can moreover be regarded as a special case of more general production functions (Constant Elasticity of Substitution (CES) production functions. It is also easy to estimate or calibrate and has quite often fitted, at least broadly, the data rather well (Willman, 2002, p.9).*

More specifically, the popularity of this form (C-D production function) has resulted from:-

- Its mathematical simplicity and computational manageability, since it specifies technology as linear in the logarithms of the variables.
- The function offers a direct estimate of returns to scale.
- Its parameters are independent of the unit of measurement since "scale change in the basic units of measurement has no essential effect on any of the terms in this logarithmic formulation except the constant term" (Klein, 1965, p. 92). These positive points may overcome some of its crucial limitations, such as unitary elasticity of substitution and the inconsistency of the relationship between marginal productivity and output.

A testable implication of the C-D production function is related to returns to scale, which depends on the value of parameters α and β which might take one of the following forms:

$\alpha + \beta = 1$ Constant Returns to Scale

$\alpha + \beta < 1$ Decrease Returns to Scale

$\alpha + \beta > 1$ Increase Returns to Scale.

Estimating the Cobb-Douglas production function (C-D) in its general form is not easy, because it is non-linear in its parameters. However, it can be estimated by taking natural logarithms, so the function can be estimated in the following form:

$$\ln Q = \beta_0 + \beta_1 \ln K + \beta_2 L + u \tag{5-2}$$

where $\beta_0 = \ln A$, $\beta_1 = \alpha$ and $\beta_2 = (1-\alpha)$

The C-D production function under the restriction of Constant Returns to Scale ($\varepsilon = 1$) can be estimated in the following form:-

$$\ln(\frac{Q}{L}) = \ln A + \beta_1 \ln(\frac{K}{L}) + u \tag{5-3}$$

The Cobb-Douglas production function assumes the stability and unilateral nature of the elasticity of substitution between production factors (labour and capital) as:-

$$\sigma = \frac{d(\frac{L}{K}) \Big/ (\frac{L}{K})}{d(\frac{\beta L}{\alpha K}) / (\frac{\beta L}{\alpha K})} \tag{5-4}$$

This assumption is a result of constant factor shares despite fluctuation in the factor prices (Douglas, 1948).

Another widely used production function in empirical studies is the Constant Elasticity of Substitution (CES) production function. Its general form can be written as follows:-

$$Q = A[\delta K^{-\rho} + (1-\delta)L^{-\rho}]^{\frac{-\varepsilon}{\rho}} \qquad (5\text{-}5)$$

The CES production function is non-linear in its parameters and cannot be linearized by taking natural logarithms, hence these specification are transferred to their linear approximation using a Taylor's series expansion formula (Kment, 1986). Thus, equation 5-5 can be estimated using the Ordinary Least Square method (OLS) and yields:

$$\ln Q = \ln A - (\varepsilon / \rho)\ln[\delta K^{-\rho} + (1-\delta)L^{-\rho}] \qquad (5\text{-}6)$$

The second item on the right hand of the production function, number 5-6 which is:-

$$f(\rho) = Ln[\delta K^{-\rho} + (1-\delta)L^{-\rho}] \qquad (5\text{-}7)$$

It is possible to stretch around the value of $\rho = 0$ to give the approximate logarithm of the CES. The CES production function form, which has random error, will be set up as follows:

$$\ln Q = \beta_0 + \beta_1 \ln K + \beta_2 L + \beta_3[\ln K - \ln L]^2 + u \qquad (5\text{-}8)$$

Where

$\beta_0 = \ln A$, $\beta_1 = \varepsilon\delta$, $\beta_2 = \varepsilon(1-\delta)$ and $\beta_3 = -(1/2)\rho\delta(1-\delta)$

This approximation is the so-called Kementa's approximation. (Sahin and Kizilirmak, 2003). Therefore, if the estimated value of β_3 in equation 5-8 does not differ from zero, this means the application of the Cobb-Douglas production function is possible. The CES production function contains constant elasticity of substitution which is equal to $\frac{1}{1+\rho}$, if $\rho = 0$ the elasticity of substitution is equal to one, meaning that the CES production function will collapse to Cobb-Douglas form (Sahin and Kizilirmak, 2003).

Equation 5-5 has a degree of returns to scale different from one ($\varepsilon \neq 1$), when it is restricted to one, the CES production function will be written as follows:-

$$Q = A[\delta K^{-\rho} + (1-\delta)L^{-\rho}]^{\frac{-1}{\rho}} u \tag{5-9}$$

The Kmenta approximation to equation 5-8 will be as follows:-

$$\ln(\frac{Q}{L}) = \ln A + \delta \ln(\frac{K}{L}) - 0.5\rho\delta(1-\delta)(\ln(\frac{K}{L}))^2 + u \tag{5-10}$$

The popularity of the CES production function has resulted mostly from it being a well behaved function; natural technical progress and return to scale are each modelled by a single parameter, it can be collapsed to the C-D form when elasticity of substitution between factors is equal to one ($\sigma = 1$), and it offers the possibility of finding the value of the elasticity of substitution.

5-3. Statistical Methods

From the existing literature, it can be seen that the same form of production functions have been used by scholars. Moreover, they use labour and capital as essential inputs, despite the different ways of entering the labour factor in these functions. It is interesting to note the majority of studies relating to developing countries, have been based on the use of the Cobb-Douglas production function, among these studies are Sadeg (1996) and Sahin (2003), while most studies, relating to developed countries, have used the CES production function to analyse the relationship between inputs and outputs and among these studies are Duffy and Papageorgion (2000), Pereire (2002) and Dunne and Watson (2005). It may also be noted that most functions which have been applied previously have using the function in its aggregate form, with the exception of the agriculture sector of these studies; this perhaps is due to the influence on agricultural production of other factors in addition to labour and capital, such as rain, temperature, fertilizers used, the quality of soil and area cultivated. Therefore the formulation of the production function in this sector must take these factors into account.

However, some of these have been excluded from this study and that was for simplification. Lack of data on these variables is another reason for the researcher to exclude these factors, although the neglect of this kind of variables may affect the significance of some statistical tests, which will indicate any weakness of the interpretation of the production function on the causal relationship between production factors.

There are many criteria according to which such discrimination can be made; using statistical tests and economic restrictions. To discriminate between the two functions (C-D and CES), the researcher has used the following criterion. Starting with the CES production function, which is more general than C-D, and is capable of being collapsed to last one, when $\sigma = 1$, where $\sigma = \frac{1}{1+\rho}$. The σ has been tested in order to discover whether the estimated value of σ is significant, when σ is found to be significant and the equation satisfies the following restrictions $0 < \sigma < 1$ and $\rho > -1$, then we assume that the best function to describe the production process in the Libyan agricultural and manufacturing sectors is the CES production function.

5-4. The function and method used to estimate the production function:

In this section, different forms of CES and C-D have been estimated in order to investigate the relative importance of factor inputs and of technical progress on economic growth in the Libyan agricultural and manufacturing sectors, and to measure the elasticity of substitution between the factors. The data are time series of the output value, number of workers and net capital stock in these sectors.

The methodology used for this purpose is based on the idea of neo-classical and endogenous growth theories. The two functions have been estimated under both specifications of constant and variant Hicks neutral technical progress. Furthermore, the growth rate of technical progress will be expressed in two ways, the first one includes t in the production function in order to capture a constant acceleration or deceleration of technical change; and the second one includes t^2 in the function in order to express a continuous acceleration or deceleration of technical change during the period from 1970 onwards.

Since there is not good a priori estimate about the value of elasticity of substitution and about the best fit production function to the Libyan economy, the two functions are estimated. Before obtaining the results of estimated production functions in the agriculture and manufacturing sectors, the equations should be represented. A basic model of the Libyan agriculture and manufacturing sectors, which using a CES specification is represented as follows:

$$Q = A((1-\delta)K^{-\rho} + \delta L^{-\rho})^{\frac{-v}{\rho}} \qquad (5\text{-}11)$$

The CES production function is non-leaner in its parameters and it cannot be estimated directly. Furthermore, it is difficult to linearize it by taking natural logarithms. Hence, these specifications are transferred to their linear approximation using a Taylor's series expansion formula (Kement, 1986). So the case of equation 5-11 can be rewritten in its linear approximation, which yields:-

$$\ln Q = \ln A + \lambda t + \Pi t^2 + \Psi D_t + \beta_1 \ln K_t + \beta_2 \ln L_t + \beta_3(\ln K_t - \ln L_t)^2 + u \qquad (5\text{-}12)$$

where A, λ, Π and Ψ are parameters to be estimated representing the efficiency parameter, the constant and variant rate of Hicks neutral technical progress and the parameter of the dummy variable. D are five dummy variables representing some structural change:

D_1 refers to the period 1992-2002 (a period of economic embargo on Libya).

D_2 refers to the period 1973-1974 (the time of the Arab-Israel war).

D_3 refers to the period 1982 (the time of a world recession)

D_4 refers to the period 2002-2008 (major structural and management changes in the country, surge in oil prices and an increase in the quota of oil exports resulting in huge increases in output)

D_5 refers to the period 1993-1996 (application of a three-year programme in agricultural sector)

The parameters of equation 5-12 are related to the parameters of the equation 5-11 in the following way:

Q_i, K_i and L_i are output value, net capital stock and number of workers in the agricultural and manufacturing sectors respectively, where i=1,2 and 3 indicating agricultural, manufacturing and productive sectors respectively.

A is constant rate and refer to the efficiency parameter.

δ is the distribution parameter representing capital intensity.

v is the returns to scale or the degree of homogeneity of the function, where $v = \beta_1 + \beta_2$.

ρ is the substitution parameter from which can be found the elasticity of substitution.

i.e. $\sigma = \frac{1}{1+\rho}$ as ρ tends to zero the CES collapses to the C-D production function ,where: $\rho = {-2\beta_3(\beta_1 + \beta_2)}/{\beta_1\beta_2}$.

However, if the restriction of Constant Returns to Scale (CRS) is made such that $v = 1$, then the linear approximation following Kmenta's formulation is as follows:

$$\ln(\frac{Q}{L_i}) = \ln A + \lambda t + \Pi t^2 + \Psi D + \delta \ln(\frac{K_i}{L_i}) - 0.5\rho\delta(1-\delta)(\ln(\frac{K_i}{L_i})^2 + u \qquad (5\text{-}13)$$

Another very widely used production function in both theoretical and empirical studies is the Cobb-Douglas function (Sadeg, 1996), and its basic specification is represented in the following equations:-

$$Q = Ae^{\lambda t+\Pi t^2+\psi D} K_i^{\beta_1} L_i^{\beta_2} e^u \qquad (5\text{-}14)$$

where $A, \lambda + \Pi, \Psi, \beta_1$ and β_2 are parameters to be estimated representing the efficiency parameter, the constant and variant rates of Hicks neutral technical progress, the parameters of dummy variables and the elasticity of substitution of output with respect to capital and with respect to labour respectively. u is assumed to be a random error term with zero mean and a constant variance. The C-D production function in the agriculture and manufacturing sectors are estimated using Ordinary Least Squares (OLS) after taking a natural logarithm and adding an error term (u) in order to transfer the equation to its linear form. This yields:

$$\ln Q = \ln A + \lambda t + \Pi t^2 + \Psi D + \beta_1 \ln K_i + \beta_2 \ln L_i + u \qquad (5\text{-}15)$$

where $\beta_1 = \alpha$ and $\beta_2 = 1 - \alpha$

In estimating the C-D production function under the restriction of Constant Returns to Scale (CRS), the equation is estimated in the following form:-

$$\ln(\frac{Q_i}{L_i}) = \ln A + \lambda t + \Pi t^2 + \Psi D + \beta_1 \ln(\frac{K_i}{L_i}) + u \qquad (5\text{-}16)$$

To discriminate between the above four specification 5-13, 5-14, 5-15 and 5-16, testing the null hypothesis that $H_0 : \rho = 0$ against the alternative one, that $H_1 : \rho \neq 0$ is the first step in the estimation process, in order to determinate the best fit function for the Libyan economy (whether CES or C-D production functions) , when the null hypothesis is rejected and ρ value is found to be significant, the CES production function will be the best in describing the production process in the Libyan productive sectors. In order to choose between the specification of constant and variant Hicks neutral technical progress and of constant and variable returns to scale in 5-13 and 5-14, their determination coefficients (R^2) value will be compared. The $F-test$ and $T-test$ will be also used, in order to discriminate the preferred specification. The $T-test$ can be applied to a test of significance of the parameter estimates. The $F-test$ is used to test the overall significance of a regression. This test aims to find out whether the explanatory variables (dependents variables) do actually have any significant influence on the independent variable. Formally the test of the overall significance of the regression implies testing the null hypothesis that:

$H_0 : \beta_1 = \beta_2 = \beta_3 = ...\beta_k = 0$

H_1 : not all β_i are zero.

If the null hypothesis is accepted, that all the parameters of the regression model are zero, meaning there is no linear relationship between independent variables and dependent variables. If none of the two specifications of the CES production function 5-13 and 5-14 satisfy the restrictions of $T-test$ and $F-test$, the C-D production function will be the preferable one, if the null hypothesis is accepted. The same procedures are followed for a matter of discrimination between specification 5-15 and 5-16 of the Cobb-Douglas production function.

5-5. Growth accounting approach:

The growth accounting approach is a method designed to quantify the contribution of factor inputs to the increase of output growth. A contribution is also made by change in technical progress or the total factor productivity (TFP). The TFP contribution is interpreted as a contribution to technical progress and/ or efficiency improvement (Minh and Long, 2008).

This concept of TFP is in general based on the context of the neo-classical growth model. The growth accounting approach is identified with the work of Solow (1957) who attributed the shift in production to the increase in production factors (labour and capital) and the shift of technical progress, as well as the work of Denison (1962), Kendrick (1961) and Jorgenson and Griliches (1967).

The output elasticity with respect to each factor input is not observable and must be estimated from the production function. This approach is quite common, and it has been used in many countries at different levels.

Willman (2002) applied a model to European area data from 1970-1997, assuming that the underlying production function is either CES or C-D. His study shows the unity of the elasticity of substitution, indicating that the CES production function was not able to explain the aggregate European data, and the Cobb-Douglas form is the correct production function. The elasticity of output-capital ratio was equal to 0.29%, and was equal to 0.35% for technical progress. Willman (2002) derived an average annual growth rate of 1.4% in total factor productivity in the estimation period.

Minh and Long (2008) studied the source of Vietnamese economic growth for the period 1985-2008, and found that economic growth was largely driven by capital and labour inputs, and partly driven by technical progress. The contribution of capital, labour and technical changes were 45.8%, 34.5% and 19.7% respectively. Their findings were based on variety of growth rates of productivity which they found for three sectors namely; industrial, agricultural and service sectors, where their productivity growth rates were 6.3%, 1.6% and -4.7% respectively. Minh and Long (2008) attributed the low technical efficiency to the inability of workers to adapt to new technology, or mismanagement in business activities.

Drawing on neo-classical theory Jajri and Ismail (2010) built a model in order to observe to what extent the Malaysian economy has benefited from educational expansion. Their model used the quality of labour and capital stock as independent variables. The quality of labour is expressed by a measure of effective labour and level of education obtained by the employment. The production and productivity functions of the Malaysian economy are estimated using data for the period 1981-2007. Jajri and Ismail (2010) found that capital stock and capital labour ratio played a major role in growing of the Malaysian economy and that effective labour also had a positive impact on Malaysian economic growth, but its contribution was less than that of physical labour. The growth accounting approach in the current study is related to neo-classical growth theory. The analysis starts from the standard aggregate neo-classical production function, which is specified as:-

$$Q(t) = A(t)f(K(t), L(t)) \qquad (5\text{-}19)$$

where Q is aggregate output, K and L are capital and labour inputs. The term A represents the unknown residual (technical progress), and t indicates time.

In applying a suitable form of production function, equation 5-19 is assumed to be an aggregate production function. However, three important points have to be kept in mind:

1. The problem of identifying the movement along the production function represented by the term $f(K,L)$, and the shift of a particular production function represented by the term A.
2. In terms of the specification of technical progress, since neo-classical growth theory assumes that it is exogenous, it does not state whether the rate of technical progress has to be constant or variable.
3. The specification of the elasticity of substitution value must be quantified.

The growth accounting formula can be easily obtained by differentiating a logarithm of equation 5-19 with respect to time and dividing both sides by Q as shown by:

$$\frac{\dot{Q}}{Q}=\frac{\dot{A}}{A}+\frac{\partial Q}{\partial K}*\frac{K}{Q}*\frac{\dot{K}}{K}+\frac{\partial Q}{\partial L}*\frac{L}{Q}*\frac{\dot{L}}{L} \tag{5-20}$$

where $\dot{K}$ and $\dot{L}$ are differentiating K and L with respect to time. The first term on the right hand side of equation 5-20 is the growth rate of technical progress or of TFP. According to the growth accounting approach, the equation could be re-written as follows:-

$$\begin{pmatrix} \text{growth rate} \\ \text{of GDP} \end{pmatrix} = \alpha \times \begin{pmatrix} \text{growth rate} \\ \text{of capital} \end{pmatrix} + \beta \times \begin{pmatrix} \text{growth rate} \\ \text{of labour} \end{pmatrix} + \begin{pmatrix} \text{growth rate} \\ \text{of technical progress} \\ \text{or TFP} \end{pmatrix}$$

or

$$G_Q = G_T + \alpha G_K + \beta G_L \tag{5-21}$$

where G_Q, G_T, G_K and G_L are the growth rate of Q, T, K and L respectively.

Neo-classical theory assumes that elasticity of output with respect to factor inputs is equal to their respective shares in national income. This assumption relies on the neo-classical theory assumption of a perfectly competitive market; it means that pay factor is assumed to be equal to its marginal product.

The equation 5-21 identifies the contribution of factor inputs to output growth as follows:-

αG_K = Contribution made by capital (K) at time t

βG_L = Contribution made by labour (L) at time t

G_T = Contribution made by technical progress or TFP at time t.

In addition technical progress or TFP is the difference between the growth rate of output and growth rates of the production factors involved. The technical progress (TFP) is considered in this study to be the effect of many factors, including substitution of capital for labour, education, improved health, economics of scale, and research and development (R & D).

In this study, the C-D and CES production functions have been used to estimate economic growth in the Libyan productive sectors. The two functions are estimated under the specification of constant and variable Hicks neutral technical progress, and under the restriction of constant returns to scale. Hence, a basic model of the Libyan productive sectors output that uses a C-D specification in its general form can be seen in the following equation:

$$Q = AtK^{\alpha}L^{\beta}e^{u} \tag{5-22}$$

where α and β are parameters to be estimated, representing the elasticity of output with respect to capital and labour respectively. u is a random error term with zero mean and a constant variance. The shares of capital and of labour are equal to α and β , and they can be used in calculating economic growth when the underlying production function is the C-D form, furthermore, those shares are constant over time.

In contrast, when using the CES production function to estimate the economic growth in the Libyan productive sectors, the shares of capital and of labour are no longer assumed to be constant when the function is a CES production function. According to the general form of CES, and according to Jalava et al (2005) these shares, with constant growth rate of technical progress, can be calculated as follows:-

$$sK = \frac{K\frac{\partial Q}{\partial K}}{Q} = \delta A^{-\rho}e^{-\lambda\rho t}[\frac{Q}{K}]^{\rho} \tag{5-23}$$

$$sL = \frac{L\frac{\partial Q}{\partial L}}{Q} = (1-\delta)A^{-\rho}e^{-\lambda\rho t}[\frac{Q}{L}]^{\rho} \tag{5-24}$$

where sK and sL are the income share of capital and labour respectively. Equations 5-23 and 5-24 show that the income share of each factor depends on the rate of technical progress and on the elasticity of substitution between capital and labour. An improvement in the productivity of capital (Q/K) and of labour (Q/L) leads to an increase in the shares of these factors when the elasticity of substitution is less than one* (Jalava et al., 2005).

The source of growth will be identified as follows:

Firstly, the input shares of production factors are constructed according to equations 5-23 and 5-24 if the CES form is the selected function. However, if the selected function is of C-D form rather than CES, α and β would be used as shares.

Secondly, by combining those shares with the growth rates of the production factors and then by adding the contribution of technical progress, the estimated growth rate of output will be obtained. In fact, there are other different methods which can be used for this purpose, for example, an annual average growth 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 growth rate 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 used in this study as they imply a comparison of two points in time and ignore any changes in the variables during the study period. The Libyan economy experienced several recessions and/ or booms

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- ρ is a substitution parameter and it is equal to $\frac{\sigma-1}{\sigma}$, when the elasticity of substitution (σ) is equal to one the ρ will approach zero.

during the period covered. The above methods would have completely failed to grasp any such possible changes.

For the above reasons the OLS method chosen. This method is assumed to identify 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.

5-6. Stationarity Test:

This study aims to estimate the production functions of the Libyan productive sector over the period 1970-2008, in order to analyse and study the effect of production factors (labour and capital), as well as technological progress on economic growth in these sectors in the long-run.

There is a belief that $T-test$ and $F-test$ indicate the presence of a significantly causal relationship between variables involved in the production process, especially when using long-term time series to test the relationship between these variables. However, in fact, what is obtained from the estimate of production functions is a contemporaneous correlation between the variables and not a causal relationship: this is because traditional regression analysis includes variables with unit roots which can give spurious regression (Thomas, 1997, p. 374). This happens when the variables involved in the production function used are non-stationary. Econometric studies argue that time series of economic variables are frequently non-stationary and at best become stationary only after differencing (Dickey and Fuller, 1981 and Hendry and Juselins, 1999).

At the presence of non-stationary data a regression process between variables may produce significant results with a high determination coefficient (R^2) value, but in fact this may be a spurious or meaningless. This is because that the concept of non-stationary variables is that their mean variance or covariance changes over time. In other words, non-stationary means that there are different values of the mean of variables at different points in time during the study period (Harris, 1995).

To avoid facing econometric problems, such as the spurious regression problem, the non stationary data can be repeatedly differenced until stationarity is achieved. The stationarity test which is a so-called unit roots test is introduced as a first step in the estimation process of this study, in order to detect and overcome this kind of problem.

However, some economic time series (Q for example) need to be differentiated in order to achieve stationarity. This can be as follows:

$$\Delta Q_t = Q_t - Q_{t-1} \tag{5-25}$$

Thus, the time series would be united or is integrated of order one $I(1)$ if it was stationary after calculating the first difference. In general, the time series are united or integrated of order d, if it is necessary to calculate its difference of (d) to be in the stationary case. In view of the importance of the stationary variables in regression analysis, the test must happen prior to the estimation process. Therefore, the first step in any applied economic study is that each variable should be tested.

Therefore, this kind of test receives close attention from economists, and there are many econometric methods in economic literature which can be used for such tests, including; Co-integrating Regression Durbin-Watson (CRDW) of Sargan and Bhargare (1983), $Z-Test$ of Philip and Perron (1987) and ADF and DF tests of Dickey and Fuller (1981). The Dickey-Fuller test is the most commonly used in applied studies. Using the Dickey Fuller test for stationary variables can be explained by assuming the following equations:

$$Q_t = \alpha Q_{t-1} + u_t \tag{5-26}$$

$$Q_t = \alpha_0 + \alpha Q_{t-1} + u_t \tag{5-27}$$

$$Q_t = \alpha_0 + \alpha Q_{t-1} + \lambda t + u_t \tag{5-28}$$

These three equations are different to each other in the sense that the arithmetic mean of time series is equal to zero in equation 5-26, and is not equal to zero in equation 5-27; the mean is not equal to zero and the equation contains a time factor in equation 5-28. The unit roots test is based on the value of α. If $\alpha \supseteq 1$, the time series of Qt are non-stationary. However, in the case of $\alpha \subset 1$, the time series of Q_t are stationary.

In equation 5-26 the time series of Q_t are stationary only in the case of $-1 \subset \alpha \subset 1$. If not, Dickey and Fuller (1981) propose some conversions to eliminate of the non-stationarity problem, and therefore equation 5-26 can be reformulated as follows:-

$$Q_t - Q_{t-1} = (\alpha - 1)Q_{t-1} + u_t \tag{5-29}$$

by assuming that $\beta = \alpha - 1$, equation 5-29 can be re-written as follows:

$$\Delta Q_t = \beta Q_{t-1} + u_t \tag{5-30}$$

where ΔQ_t is first difference of series Q_t

To test equation 5-30 Dickey and Fuller proposed two kinds of tests. The first one is $DF-test$, which is based on estimating equation 5-30 and testing whether $\beta = 0$. This test is valid only if the value of the residual (u_t) in equation 5-30 does not suffer from an auto-correlation problem, but if (u_t) suffers from this problem, the second test, which is known as the Augmented Dickey-Fuller test (ADF) must be used, which is enough to remove this problem. In both tests, the degree of $t-test$ for the variable Q_{t-1} can be assured by comparison with the values indexed by Dickey and Fuller (Dickey and Fuller, 1981).

5-7. Co-integration test:

The concept of co-integration is based on the fact that if the level of variables of the model is not stationary, but they co-integrate in their first level, they can be used in the regression process, and the regression will not be spurious. Hendry and Juselius (1999, p. 18) state that *"when data are non-stationary purely due to unit roots, they can be brought back to stationarity by linear transformations"*. The statistical concept of the co-integration is the existence of a long run equilibrium relationship between variables in the economic system over time. To illustrate this, a simple regression can be made, as in the following equation:

$$Q_t = f(K_t, L_t)$$

where $Q_t \sim I(d)$ $K_t \sim I(d)$ and $L_t \sim I(d)$

The Ordinary Least Squares (OLS) can be used to test if u is integrated of the order zero, $I(0)$ where u are residuals of the co-integration regression. If the residuals are integrated of zero $I(0)$, hence, the variables used in the regression model are co-integrated of order one $I(1)$. Then their level can be used in the regression process, thus avoiding the loss of information inherent in the long-run level of variables, if their first difference is used. The co-integration test is based on the knowledge of whether u are stationary or integrated of order zero $I(0)$. Co-integration brings with it two econometric questions. The first is how to estimate the co-integration parameters and the second is how to test whether two or more variables are co-integrated or spurious. The first step to test the co-integration is a long-run regression for each of the following equations in order to obtain residuals regression. Then the Unit Root Test is applied on these residuals. This approach is the Augmented Dickey-Fuller residual-based test proposed by Engle and Granger (1987).

$$u = \ln Q_{it} - \beta_0 - \beta_1 \ln K_{it} - \beta_2 L_{it} \tag{5-31}$$

and

$$u = \ln(\frac{Q}{L})_{it} - \beta_0 - \beta_1 \ln(\frac{K}{L})_{it} \tag{5-32}$$

and

$$u = \ln Q_{it} - \beta_0 - \beta_1 \ln K_{it} - \beta_2 L_{it} - \beta_3 (\ln K_{it} - \ln L_{it})^2 \tag{5-33}$$

and

$$u = \ln(\frac{O}{L})_{it} - \beta_0 - \beta_1 \ln(\frac{K}{L})_{it} - \beta_2 (\ln(\frac{K}{L})_{it})^2 \tag{5-34}$$

$i = 1,2$ and 3 representing agriculture, manufacturing and productive (agriculture + manufacturing) sectors.

These equations are called co-integration regression, and (u) is a linear combination (residuals) generated by the regression of a long-run equilibrium relationship. This co-integration test is based on verifying that (u) are stationary; integrated of zero $I(0)$. This involves estimating

$$\Delta u_t = \alpha_0 + \beta_0 u_{t-1} + \varepsilon_t$$

where ε is white noise. If β_0 is significant, then the null hypothesis that; $\Delta u_t \sim I(1)$ would be rejected, and the alternative hypothesis that $\Delta u_t \sim I(0)$ would be accepted. The Engle and Granger approach is analogous to univariate tests used to determine the order of integration of variables, but here it is the residuals that are tested. The major drawback of Engle and Granger's method is that it implies a unique co-integration vector. However, in the real world all the economic relationships are complicated, and where a co-integrating regression has more than two variables, there may be more than one co-integrating vector. Thus, the use of this approach in this study is not appropriate. This led to further testing. There are many other statistical tests that have been developed to test the integration of time series, including those of Durban-Watson, and the Johansen–Juseliues co-integration test which has become the standard in the econometric literature (Turner, 2007). The Johansen integration approach has been used in this study, to examine the long run relationship between the exogenous and endogenous variables of the model, and to test the co integration between the variables.

Johansen (1988, 1991) suggested using two test statistics for the number of independent co-integration vectors r (r is number of co-integration vectors), based on the number of significant eigenvalues of the co integration matrix. Maximal eigenvalue is employed to test the null hypothesis that $r \subseteq q$ against of the alternative hypothesis that $r = q$, and to use Trace test for the null hypothesis that $r \subseteq q$ against of the alternative one that $r \subseteq q+1$. The latter approach is adopted in this study because it allows the estimation of all the possible co-integrating relationships existing among the variables, and it allows the number of co-integrating vectors to be determined empirically.

CHAPTER SIX

An estimation of the production function in the Libyan Agriculture and Manufacturing sectors

6-1. Introduction:

The aim of this study is the econometric analysis of Libyan economic growth over the period 1970-2008. A small macro-econometric model for the Libyan economy has been constructed. A production function for Gross Domestic Product in the Libyan productive sector (agriculture and manufacturing sectors) is estimated using a wide range of statistical tests in order to find the relative importance of factor inputs and of technical progress on economic growth in these sectors, and to measure elasticity of substitution and returns to scale. The study also set out to find an answer to a number of questions such as; what specification of the production function (C-D or CES) is more suitable for the Libyan economy and what are the input factors which have affected the output of the agriculture and manufacturing sectors in the last thirty eight (1970-2008) years.

Both the C-D and CES production functions are used and a wide range of econometric tests are employed. The two functions are estimated using constant and variant forms of technical progress and under the assumption of variant and constant returns to scale.

The neo-classical approach is used to estimate the model. The rest of this chapter is divided into eight main sections. Application of stationarity and the order of integration tests of each individual variable will be the first step in the estimation process, which are presented in sections 6-2 and 6-3 respectively. Section 6-4 contains estimations of the long-run relationship between endogenous and exogenous variables in the agricultural sector, using both C-D and CES production functions, and discusses the econometric results. Section 6-6 presents the estimation results of the Libyan manufacturing production functions. Measurement of average and marginal product of factor inputs (capital and labour) in the agricultural and manufacturing sectors will be presented in sections 6-5 and 6-7. Section 6-8 contains the conclusion.

6-2. Application of stationarity test:

Most economic time series are not stationary, and examining each variable individually should be the first step in any empirical study, starting by subjecting the variables to a unit roots test using the Dickey-Fuller (DF) and the Augmented Dickey Fuller (ADF) tests. The essence of the Dickey–Fuller test is rejection of the null hypothesis. The null hypothesis is that the time series has a unit root, i.e. $H_0 : \beta_0 = 0$ is tested against the alternative of stationary, i.e. $H_1 : \beta_0 \subset 0$.

If the null hypothesis is rejected, then the time series of the variable is stationary, and if the null hypothesis is not rejected, then the time series is non-stationary. The critical values related to $t-statistics$ are taken from the tables of Mackinnon (1991). Table 6-1 presents the results of the unit roots hypothesis test for all the variables at the 5% and 10% significance level. DF and ADF have been tested for all variables by applying equations 5-27 and 5-28. The table presents the DF and the ADF results on the level and first difference of the variables. The tables contain the results of each variable used in the estimation process in all sectors covered by this study. Numbers 1, 2 and 3 refer to the agriculture, manufacturing and productive sectors respectively.

The DF and ADF test are calculated both with and without time trend. The null hypothesis is tested against its alternative. The results seem to accept the null hypothesis of a unit root in their level with the exception of DF in the case of $(\ln K/L)_1^2$. This indicates that the time series are not stationary using the absolute value of variables.

However, the null hypothesis is rejected in the case of their first difference, the result indicated that all variables are stationary, confirming the possibility of using the first difference of variable values in the estimation process.

Table 6-1

The result of unit roots test of the variables used in estimation of the production functions.

WITHOUT TIME TREND						WITH TIME TREND					
VARIABLE	DF	DF(1)	ADF(0)	ADF(1)	ADF(2)	DF	DF(1)	ADF(0)	ADF(1)	ADF(2)	CONCLUSION
Ln Y_1	-0.43	-4.93	-1.71	-6.11		-1.91	-5.87	-2.12	-6.10		$I(1)$
Ln Y_2	0.52	-3.32	-0.79	-4.00			-3.76	-1.06	-3.95		$I(1)$
Ln Y_3	0.33	-3.13	-1.26	-4.72		-1.25	-4.02	-1.46	-4.75		$I(1)$
Ln K_1	-0.04	-2.63	-1.30	-2.70		-0.96	-2.73	-1.22	-2.69	-7.40	$I(1)$
Ln K_2	-0.93	-2.26	-2.49	-2.23	-8.49	-1.39	-2.50	-3.05	-2.51	-8.44	$I(1)$
Ln K_3	-0.75	-2.42	-2.91	-2.42		-1.39	-2.62	-2.70	-2.65		$I(1)$
Ln L_1	-0.95	-5.76	-0.79	-5.69		-0.99	-6.27	-0.64	-6.13		$I(1)$
Ln L_2	1.17	-6.14	-1.40	-6.21		-1.90	-6.45	-2.10	-6.37		$I(1)$
Ln L_3	-0.13	-4.59	-1.39	-4.62		-1.46	-4.85	-0.91	-4.77		$I(1)$
(Ln (K/L)$^{2}_{1}$	1.75	-3.15	1.36	-3.11		-0.08	-3.39	0.87	-3.27		$I(1)$
(Ln (K/L)$^{2}_{2}$	-0.05	-2.65	0.11	-2.62		-1.49	-2.87	-3.24	-2.83		$I(1)$
(Ln (K/L)$_3^2$	-0.82	-2.15	-1.31	-2.13	-6.50	-1.29	-2.23	-2.36	-2.21	-6.47	$I(1)$
Ln (Y/L)$_1$	0.51	-4.61	0.10	-5.70		-1.16	-5.44	-0.71	-5.68		$I(1)$
Ln (Y/L)$_2$	-0.93	-4.08	-0.96	-4.76		-0.98	-4.58	-0.81	-4.68		$I(1)$
Ln (Y/L)$_3$	-0.41	-3.17	-0.87	-4.45		-0.95	-3.91	-0.86	-4.36		$I(1)$
Ln (K/L)$_1$	0.61	-3.44	-0.19	-3.44		-0.68	-3.51	-0.40	-3.42		$I(1)$
Ln (K/L)$_2$	0.05	-3.42	0.17	-3.38		-1.42	-3.66	-2.73	-3.59		$I(1)$
Ln (K/L)$_3$	-0.85	-2.46	-1.40	-2.44	-7.415	-1.30	-2.53	-2.25	-2.51	-7.39	$I(1)$
	5%	CV				5%	CV				
	DF	-1.95				DF	-3.19				
	ADF	-2.94				ADF	-3.53				
	10%	CV				10%	CV				
	DF	-1.61				DF	-2.89				
	ADF	-2.61				ADF	-3.19				

CV= test critical value of Mackinnon (1991)

6-3. Application of Co-integration Test:

According to the Unit Roots test of the variables used in the estimation of production functions in the agriculture, manufacturing and productive (agriculture + manufacturing) sectors, all variables are non-stationary in their level, but they are in their first difference. The Johansen method is applied to the data of the agriculture, manufacturing and productive sectors, in order to investigate whether any stable long-run relationships exist between dependent and independent variables.

Tables 6-2, 6-3 and 6-4 present the results of the Johansen test of the co-integration between the variables in the agriculture, manufacturing and productive sectors respectively. Fonts a, b, c and d refer to the results of the co-integration test in specifications 5-31, 5-32, 5-33 and 5-34 respectively. The Johansen-Juseliues co-integration test has been used with and without time trend, in order to test the null hypothesis that $r = 0$, which indicates the absence of co-integration between variables, against the alternative hypothesis that, $r = 1$ which indicates the presence of co-integration between the variables of the model.

The tables show that the maximal eigenvalue and trace statistics are all significant at 5% and 10%, the null hypothesis is rejected in all specifications, indicating that one co-integration vector exists between the variables in all the equations.

Table 6-2: Johansen – Juselius Maximum Likelihood Co-integration Test:

Where r denotes the number of Co-integration vectors.

Table 6-2.a

List of variables included in the co-integrating vector of agricultural sector.

$\ln Q$ $\ln K$ $\ln L$ $(\ln K - \ln L)^2$

a: Trace test

Null	*Alternative*	*Statistic*		*5% C.V*		*10% C.V*	
		trend	*No trend*	*trend*	*No trend*	*trend*	*No trend*
r=0	*r=1*	*69.61*	*60.25*	*63.87*	*47.85*	*60.08*	*44.49*
r≤1	*r=2*	*38.41*	*29.99*	*42.91*	*29.79*	*39.75*	*27.06*
r≤2	*r=3*	*19.68*	*14.14*	*25.87*	*15.49*	*23.34*	*13.42*
r≤3	*r=4*	*7.93*	*4.52*	*12.51*	*3.84*	*10.66*	*2.70*

C.V= Critical value.

b: Maximal Eigenvalue Test

Null	*alternative*	*Statistic*		*5% C.V*		*10% C.V*	
		trend	*No trend*	*trend*	*No trend*	*trend*	*No trend*
r=0	*r=1*	*31.21*	*30.26*	*32.11*	*27.58*	*29.54*	*25.12*
r≤1	*r=2*	*18.72*	*15.84*	*25.82*	*21.13*	*23.44*	*18.89*
r≤2	*r=3*	*11.75*	*9.62*	*19.38*	*14.26*	*17.23*	*12.29*
r≤3	*r=4*	*7.93*	*4.52*	*12.51*	*3.84*	*10.66*	*2.70*

Table 6-2.b

List of variables included in the co- integrating vector of the agriculture sector.

$\ln Q$ $\ln K$ $\ln L$

a: Trace test

Null	*Alternative*	*Statistic*		*5% C.V*		*10% C.V*	
		Trend	*No trend*	*Trend*	*No trend*	*Trend*	*No trend*
r=0	*r=1*	*47.43*	*33.06*	*42.91*	*29.79*	*49.36*	*35.45*
r≤1	*r=2*	*18.69*	*5.48*	*25.87*	*15.49*	*31.15*	*19.93*
r≤2	*r=3*	*5.00*	*0.004*	*12.51*	*3.84*	*16.55*	*6.63*

C.V= Critical value.

b: Maximal Eigenvalue Test

Null	*Alternative*	*Statistic*		*5% C.V*		*10% C.V*	
		Trend	*No trend*	*Trend*	*No trend*	*Trend*	*No trend*
r=0	*r=1*	*28.74*	*27.57*	*25.82*	*21.13*	*30.83*	*25.86*
r≤1	*r=2*	*13.68*	*5.48*	*19.38*	*14.26*	*23.97*	*18.52*
r≤2	*r=3*	*5.00*	*0.004*	*12.51*	*3.84*	*16.55*	*6.63*

Table 6-2.c

List of variables included in the co- integrating vector of the agriculture sector.

$\ln(Q/L)$ $\ln(K/L)$ $(\ln(K/L))^2$

a: Trace test

Null	*Alternative*	*Statistic*		*5% C.V*		*10% C.V*	
		Trend	*No trend*	*Trend*	*No trend*	*Trend*	*No trend*
r=0	*r=1*	*43.41*	*29.48*	*42.91*	*29.79*	*39.75*	*27.06*
r≤1	*r=2*	*21.92*	*11.50*	*25.87*	*15.49*	*23.34*	*13.42*
r≤2	*r=3*	*7.86*	*2.21*	*12.51*	*3.84*	*10.66*	*2.70*

C.V= Critical value.

b: Maximal Eigenvalue Test

Null	*alternative*	*Statistic*		*5% C.V*		*10% C.V*	
		trend	*No trend*	*trend*	*No trend*	*trend*	*No trend*
r=0	*r=1*	*21.49*	*17.98*	*25.82*	*21.13*	*23.44*	*18.89*
r≤1	*r=2*	*14.05*	*9.29*	*19.38*	*14.26*	*17.23*	*12.29*
r≤2	*r=3*	*7.86*	*2.21*	*12.51*	*3.84*	*10.66*	*2.70*

Table 6-2.d

List of variables included in the co- integrating vector of the agriculture sector.

$\ln(Q/L)$ $\ln(K/L)$

a: Trace test

Null	*Alternative*	*Statistic*		*5% C.V*		*10% C.V*	
		Trend	*No trend*	*Trend*	*No trend*	*Trend*	*No trend*
r=0	*r=1*	*16.02*	*3.92*	*25.87*	*15.49*	*23.34*	*13.42*
r≤1	*r=2*	*3.14*	*0.15*	*12.51*	*3.84*	*10.66*	*2.70*

C.V= Critical value.

b: Maximal Eigenvalue Test

Null	*Alternative*	*Statistic*		*5% C.V*		*10% C.V*	
		Trend	*No trend*	*Trend*	*No trend*	*Trend*	*No trend*
r=0	*r=1*	*12.88*	*3.76*	*19.38*	*14.26*	*17.23*	*12.29*
r≤1	*r=2*	*3.14*	*0.15*	*12.51*	*3.84*	*10.66*	*2.70*

Table 6-3.a

List of variables included in the co- integrating vector of the manufacturing sector.

$\ln Q$ $\ln K$ $\ln L$ $(\ln K - \ln L)^2$

a: Trace test

Null	*Alternative*	*Statistic*		*5% C.V*		*10% C.V*	
		Trend	*No trend*	*trend*	*No trend*	*trend*	*No trend*
r=0	*r=1*	*72.48*	*58.77*	*63.87*	*47.85*	*60.08*	*44.49*
r≤1	*r=2*	*34.86*	*21.32*	*42.91*	*29.79*	*39.75*	*27.06*
r≤2	*r=3*	*17.46*	*10.49*	*25.87*	*15.49*	*23.34*	*13.42*
r≤3	*r=4*	*7.03*	*2.56*	*12.51*	*3.84*	*10.66*	*2.70*

C.V= Critical value.

b: Maximal Eigenvalue Test

Null	*Alternative*	*Statistic*		*5% C.V*		*10% C.V*	
		trend	*No trend*	*Trend*	*No trend*	*Trend*	*No trend*
r=0	*r=1*	*37.62*	*37.44*	*32.11*	*27.58*	*29.54*	*25.12*
r≤1	*r=2*	*17.40*	*10.83*	*25.82*	*21.13*	*23.44*	*18.89*
r≤2	*r=3*	*10.42*	*7.92*	*19.38*	*14.26*	*17.23*	*12.29*
r≤3	*r=4*	*7.03*	*2.56*	*12.51*	*3.84*	*10.66*	*2.70*

Table 6-3.b

List of variables included in the co- integrating vector of manufacturing sector.

$\ln Q$ $\ln K$ $\ln L$

a: Trace test

Null	*Alternative*	*Statistic*		*5% C.V*		*10% C.V*	
		Trend	*No trend*	*Trend*	*No trend*	*Trend*	*No trend*
r=0	*r=1*	*45.08*	*38.00*	*42.91*	*29.79*	*49.36*	*35.45*
r≤1	*r=2*	*15.79*	*9.04*	*25.87*	*15.49*	*31.15*	*19.93*
r≤2	*r=3*	*5.25*	*3.62*	*12.51*	*3.84*	*16.55*	*6.63*

C.V= Critical value.

b: Maximal Eigenvalue Test

Null	*Alternative*	*Statistic*		*5% C.V*		*10% C.V*	
		Trend	*No trend*	*Trend*	*No trend*	*Trend*	*No trend*
r=0	*r=1*	*29.29*	*28.95*	*25.82*	*21.13*	*30.83*	*25.86*
r≤1	*r=2*	*10.53*	*5.42*	*19.38*	*14.26*	*23.97*	*18.52*
r≤2	*r=3*	*5.25*	*3.62*	*12.51*	*3.84*	*16.55*	*6.63*

Table 6-3.c

List of variables included in the co-integrating vector of manufacturing sector.

$\ln(Q/L)$ $\ln(K/L)$ $(\ln(K/L))^2$

a: Trace test

Null	*Alternative*	*Statistic*		*5% C.V*		*10% C.V*	
		Trend	*No trend*	*Trend*	*No trend*	*Trend*	*No trend*
r=0	*r=1*	*54.62*	*33.68*	*42.91*	*29.79*	*39.75*	*27.06*
r≤1	*r=2*	*27.47*	*11.81*	*25.87*	*15.49*	*23.34*	*13.42*
r≤2	*r=3*	*9.10*	*2.69*	*12.51*	*3.84*	*10.66*	*2.70*

C.V= Critical value.

b: Maximal Eigenvalue Test

Null	*Alternative*	*Statistic*		*5% C.V*		*10% C.V*	
		Trend	*No trend*	*Trend*	*No trend*	*Trend*	*No trend*
r=0	*r=1*	*27.14*	*21.87*	*25.82*	*21.13*	*23.44*	*18.89*
r≤1	*r=2*	*18.37*	*9.11*	*19.38*	*14.26*	*17.23*	*12.29*
r≤2	*r=3*	*9.10*	*2.69*	*12.51*	*3.84*	*10.66*	*2.70*

Table 6-3.d

List of variables included in the co- integrating vector of manufacturing sector.

$\ln(Q/L)$ $\ln(K/L)$

a: Trace test

Null	*Alternative*	*Statistic*		*5% C.V*		*10% C.V*	
		Trend	*No trend*	*Trend*	*No trend*	*Trend*	*No trend*
r=0	*r=1*	*29.33*	*14.15*	*25.87*	*15.49*	*23.34*	*13.42*
r≤1	*r=2*	*9.70*	*2.58*	*12.51*	*3.84*	*10.66*	*2.70*

C.V= Critical value.

b: Maximal Eigenvalue Test

Null	*Alternative*	*Statistic*		*5% C.V*		*10% C.V*	
		Trend	*No trend*	*Trend*	*No trend*	*Trend*	*No trend*
r=0	*r=1*	*19.63*	*11.57*	*19.38*	*14.26*	*17.23*	*12.29*
r≤1	*r=2*	*9.70*	*2.58*	*12.51*	*3.84*	*10.66*	*2.70*

Table 6-4.a

List of variables included in the co- integrating vector of productive sector (manufacturing + agriculture sectors).

$\ln Q$ $\ln K$ $\ln L$ $(\ln K - \ln L)^2$

a: Trace test

Null	*Alternative*	*Statistic*		*5% C.V*		*10% C.V*	
		Trend	*No trend*	*Trend*	*No trend*	*Trend*	*No trend*
r=0	*r=1*	*64.96*	*56.11*	*63.87*	*47.85*	*60.08*	*44.49*
r≤1	*r=2*	*27.71*	*22.42*	*42.91*	*29.79*	*39.75*	*27.06*
r≤2	*r=3*	*15.88*	*11.09*	*25.87*	*15.49*	*23.34*	*13.42*
r≤3	*r=4*	*5.67*	*3.55*	*12.51*	*3.84*	*10.66*	*2.70*

C.V= Critical value.

b: Maximal Eigenvalue Test

Null	*Alternative*	*Statistic*		*5% C.V*		*10% C.V*	
		Trend	*No trend*	*Trend*	*No trend*	*Trend*	*No trend*
r=0	*r=1*	*37.25*	*33.69*	*32.11*	*27.58*	*29.54*	*25.12*
r≤1	*r=2*	*11.82*	*11.33*	*25.82*	*21.13*	*23.44*	*18.89*
r≤2	*r=3*	*10.21*	*7.53*	*19.38*	*14.26*	*17.23*	*12.29*
r≤3	*r=4*	*5.67*	*3.55*	*12.51*	*3.84*	*10.66*	*2.70*

Table 6-4.b

List of variables included in the co- integrating vector of productive sector manufacturing+agriculture sectors).

$\ln Q$ $\ln K$ $\ln L$

a: Trace test

Null	*Alternative*	*Statistic*		*5% C.V*		*10% C.V*	
		Trend	*No trend*	*Trend*	*No trend*	*Trend*	*No trend*
r=0	*r=1*	*48.08*	*44.09*	*42.91*	*29.79*	*39.75*	*27.06*
r≤1	*r=2*	*15.88*	*12.93*	*25.87*	*15.49*	*23.34*	*13.42*
r≤2	*r=3*	*5.29*	*5.16*	*12.51*	*3.84*	*10.66*	*2.70*

C.V= Critical value.

b: Maximal Eigenvalue Test

Null	Alternative	Statistic		5% C.V		10% C.V	
		Trend	No trend	Trend	No trend	Trend	No trend
r=0	r=1	32.20	31.15	25.82	21.13	23.44	18.89
r≤1	r=2	10.58	7.76	19.38	14.26	17.23	12.29
r≤2	r=3	5.29	5.16	12.51	3.84	10.66	2.70

Table 6-4.c

List of variables included in the co- integrating vector of productive sector.

$\ln(Q/L)$ $\ln(K/L)$ $(\ln(K/L))^2$

a: Trace test

Null	Alternative	Statistic		5% C.V		10% C.V	
		Trend	No trend	Trend	No trend	Trend	No trend
r=0	r=1	40.86	22.35	42.91	29.79	39.75	27.06
r≤1	r=2	15.28	10.31	25.87	15.49	23.34	13.42
r≤2	r=3	6.83	2.99	12.51	3.84	10.66	2.70

C.V= Critical value.

b: Maximal Eigenvalue Test

Null	Alternative	Statistic		5% C.V		10% C.V	
		Trend	No trend	Trend	No trend	Trend	No trend
r=0	r=1	25.58	12.04	25.82	21.13	23.44	18.89
r≤1	r=2	8.45	7.31	19.38	14.26	17.23	12.29
r≤2	r=3	6.83	2.99	12.51	3.84	10.66	2.70

Table 6-4.d

List of variables included in the co- integrating vector of productive sector.

$\ln(Q/L)$ $\ln(K/L)$

a: Trace test

Null	Alternative	Statistic		5% C.V		10% C.V	
		Trend	No trend	Trend	No trend	Trend	No trend
r=0	r=1	19.0	14.41	25.87	15.49	23.34	13.42
r≤1	r=2	4.70	2.93	12.51	3.84	10.66	2.70

C.V= Critical value.

b: Maximal Eigenvalue Test

Null	*Alternative*	*Statistic*		*5% C.V*		*10% C.V*	
		Trend	*No trend*	*Trend*	*No trend*	*Trend*	*No trend*
r=0	*r=1*	*14.3*	*11.4*	*19.38*	*14.26*	*17.23*	*12.29*
r≤1	*r=2*	*4.70*	*2.93*	*12.51*	*3.84*	*10.66*	*2.70*

6-4 Econometrics results and a discussion of the estimation of the agricultural production function:

Econometric estimation results are provided in table 6-5 and 6-6. The production functions were estimated for both kinds of function to the Libyan agricultural sector over the period 1970-2008. The tables summarize the OLS estimates in the level of absolute value of the variable of the Libyan agriculture sector. Table 6-5 shows the estimation results for the CES production function (Kmenta approximation) using the absolute value of variables of the Libyan agriculture sector. Results of the static regression of different specifications are presented in the tables, the first nine columns providing the unrestricted specification of (CRS), and the last six columns of the same table providing the results of the restricted (CRS) specification.

Table (6-5)

Estimation of the CES production function, using the absolute value of variables under both specifications of Constant and Variant Hicks neutral technical progress, and under the restriction of Constant and Variable Returns to Scale, specific to the Libyan agriculture sector.

	Variable Returns to Scale (VRS)									Constant Returns to Scale (CRS)					
Equations	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**1**	**2**	**3**	**4**	**5**	**6**
Variables															
Constant	0.96 (2.32)**	0.13 (0.33)	1.80 (2.43)***	0.93 (2.24)**	0.89 (2.08)**	0.94 (2.16)**	1.50 (2.43)***	1.56 (2.51)***	1.84 (2.46)***	-0.75 (-4.8)***	-0.86 (-5.7)***	-0.77 (-4.9)***	-0.77 (-4.8)***	-0.76 (-4.9)***	3.50 (23.7)***
$\ln K$	0.54 (3.64)***	0.60 (3.67)***	0.46 (2.85)***	0.54 (3.62)***	0.52 (3.42)***	0.52 (3.41)***	0.61 (3.66)***	0.62 (3.67)***	0.54 (2.68)***						
$\ln L$	0.06 (0.28)	0.17 (0.74)	-0.017 (-0.08)	0.06 (0.28)	0.08 (0.39)	0.07 (0.32)	-0.14 (-0.50)	-0.15 (-0.55)	-0.13 (-0.48)						
$\ln(K/L)$										0.14 (0.96)	0.36 (2.52)***	0.12 (0.88)	0.12 (0.86)	0.17 (1.22)	1.00 (7.16)***
$(\ln K - \ln L)^2$	-0.02 (-0.53)	-0.02 (-0.56)	-0.01 (-0.27)	-0.01 (-0.37)	-0.01 (-0.27)	-0.01 (-0.34)	-0.01 (-0.90)	-0.04 (-0.91)	-0.03 (-0.64)	0.11 (3.24)***	0.05 (1.54)	0.11 (3.36)***	0.11 (3.31)***	0.10 (2.83)***	-0.16 (-4.9)***
t	0.016 (10.02)***		0.03 (2.64)***	0.01 (6.08)***	0.01 (5.97)***	0.01 (5.94)***	0.01 (4.88)***	0.02 (4.96)***	0.02 (2.09)	0.01 (7.35)***		0.01 (4.18)***	0.01 (4.07)***	0.01 (2.66)***	0.02 (8.58)***
t^2		0.0004 (9.12)***	-0.0004 (-1.36)*						-0.0002 (-0.69)		0.0004 (8.17)***				
D_1				0.04 (0.83)	0.04 (0.76)	0.04 (0.70)	0.02 (0.45)	0.04 (0.74)				0.04 (0.67)	0.04 (0.66)	0.06 (0.89)	0.02 (0.31)
D_2					0.03 (0.53)	0.03 (0.62)	0.03 (0.61)	0.03 (0.60)				0.07 (1.09)	0.07 (1.06)	0.05 (0.90)	0.01 (0.17)
D_3						0.07 (0.71)	0.08 (0.83)	0.08 (0.81)					0.002 (0.02)	0.01 (0.13)	0.13 (1.23)
D_4							-0.11 (-1.26)	-0.13 (-1.48)*	-0.07 (-0.73)					0.13 (1.81)**	-0.36 (-4.8)***
D_5								-0.06 (-0.95)							-0.08 (-1.11)
R^2	0.94	0.93	0.94	0.94	0.93	0.93	0.94	0.94	0.94	0.95	0.96	0.95	0.95	0.96	0.92
F	125.0	107.9	102.9	99.2	81.05	68.47	61.2	54.4	84.6	223.1	256.5	133.4	107.8	99.4	45.2
DW	1.58	1.49	1.64	1.57	1.60	1.69	1.75	1.81	1.63	1.38	1.51	1.42	1.42	1.66	1.94

Figures in the brackets are the $t - value$, **** significant at the 1% level; **significant at the 5% level; * significant at the 10% level.*

t *refers to constant rate of technical progress.*

t^2 *refers to variable rate of technical progress.*

$\ln Q$ *and* $\ln(Q/L)$ *as dependent variables for the unrestricted and the restricted specification respectively.*

According to table 6-5 the coefficient values of $(\ln K - \ln L)^2$ are not significantly different from zero, implying a C-D production function. The coefficient values of the CES are not all significant except for equations 2 and 6 on the right side of the table.

Table 6-6 summarizes the estimation results for the parameters of the CES function, according to equation 4 from table 6-5, and from table 6-6, the ρ value is not different from zero; this implies that the elasticity of substitution between factor inputs is nearly equal to one, this also confirms that the C-D production function is preferable for the Libyan agriculture sector.

Table 6-6: estimation result of CES parameters of the Libyan agriculture sector

Variables	*Coefficient values*
A	2.53
ε	0.60
ρ	0.30
σ	0.77

The estimation result of the specification of the C-D production function is presented in table 6-7. The C-D production function was also estimated using the absolute value of variable, relaxing some restrictive hypotheses of the neo-classical framework, such as perfect competition, constant and variant returns to scale and Hicks neutral technical progress. The estimation results of the Variable Returns to Scale (VRS) and Constant Returns to Scale (CRS) are presented on the left and right sides of the table respectively. The OLS method was used to estimate the C-D production function in the Libyan agriculture sector over the period 1970-2008, all variables are expressed in 1980 base year pricing.

Table (6-7)

*Estimation of the **C-D** production function, using the absolute value of variables under both specifications of Constant and Variant Hicks neutral technical progress, and under the restriction of Constant and Variable Returns to Scale, specific to the Libyan agricultural sector.*

	Variable Returns to Scale (VRS)									Constant Returns to Scale (CRS)					
Equations	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**1**	**2**	**3**	**4**	**5**	**6**
Variables															
Constant	0.49 (0.65)	**0.85** **(2.42)***	0.035 (0.092)	1.78 (2.60)***	0.85 (2.43)***	0.82 (2.32)**	0.86 (2.38)**	1.13 (2.47)***	1.18 (2.57)***	-1.21 (-12 6)***	-1.21 (-12.6)***	-1.21 (-12.4)***	-1.11 (-11.1)***	-1.11 (-10.9)	-1.08 (-11.5)***
$\ln K$	0.60 (9.02)***	**0.46** **(14.10)***	0.51 (15.03)***	0.41 (8.75)***	0.48 (11.4)***	0.48 (11.1)***	0.47 (10.71)***	0.47 (10.42)***	0.47 (10.4)***						
$\ln L$	0.12 (1.23)	**0.18** **(3.80)***	0.29 (5.65)***	0.035 (0.34)	0.14 (2.40)**	0.14 (2.45)***	0.14 (2.43)***	0.10 (1.28)	0.09 (1.12)						
$\ln(K/L)$										0.59 (10.7)***	0.58 (10.3)***	0.58 (10.0)***	0.56 (10.2)***	0.56 (10.0)	0.57 (12.07)***
$(\ln K - \ln L)^2$															
t		**0.016** **(11.48)***		0.035 (2.73)***	0.014 (6.78)***	0.015 (6.52)***	0.015 (6.49)***	0.01 (5.44)***	0.01 (5.51)***	0.01 (4.97)***	0.01 (4.95)***	0.01 (4.77)***	0.01 (2.77)***	0.01 (2.73)	
t^2			0.0004 (10.51)***	-0.0006 (-1.50)*											0.0003 (3.92)***
D_1					0.05 (0.92)	0.04 (0.83)	0.04 (0.78)	0.04 (0.68)	0.06 (0.96)	0.0008 (0.01)	-0.006 (-0.07)	-0.005 (-0.06)	0.02 (0.34)	0.03 (0.38)	0.03 (0.46)
D_2						0.03 (0.63)	0.03 (0.69)	0.04 (0.74)	0.04 (0.73)		0.06 (0.82)	0.06 (0.82)	0.04 (0.65)	0.04 (0.64)	0.05 (0.82)
D_3							0.06 (0.69)	0.07 (0.72)	0.06 (0.70)			-0.01 (-0.10)	0.006 (0.05)	0.006 (0.04)	0.03 (0.25)
D_4								-0.07 (-0.96)	-0.10 (-1.20)				0.18 (2.39)**	0.18 (2.19)	0.03 (0.36)
D_5									-0.05 (-0.94)					-0.01 (-0.17)	-0.03 (-0.43)
R^2	0.69	**0.94**	0.93	0.94	0.93	0.93	0.93	0.94	0.94	0.93	0.93	0.93	0.94	0.94	0.95
F	40.80	**170.1**	146.7	132.2	127.2	100.0	82.1	70.3	61.4	168.6	125.7	97.6	93.9	78.1	95.07
DW	0.32	**1.61**	1.52	1.65	1.58	1.62	1.70	1.72	1.77	1.00	1.06	1.05	1.38	1.37	1.49

Figures in the brackets are the $t-\text{value}$ *,*** significant at the 1% level; **significant at the 5% level; * significant at the 10% level.*

t *refers to constant rate of technical progress.*

t^2 *refers to variable rate of technical progress.*

$\ln Q$ *and* $\ln(Q/L)$ *as dependent variables for the unrestricted and the restricted specification respectively.*

Equation 2 in Table 6-7 employing the C-D production function with a constant form of Hicks neutral technical change was adopted because it gives the best results; it is written as following:-

$$\ln Q = 0.85 + 0.46 \ln K + 0.18 \ln L + 0.016t \qquad (6\text{-}1)$$

$T - values$ (2.42) (14.10) (3.80) (11.48)

$R^2 = 0.94$ $F = 40.80$ $D - W = 1.61$

where $\ln Q$ is a natural logarithm of agricultural GDP, $\ln K$ and $\ln L$ are natural logarithms of capital stock and number of workers in the sector respectively. t indicates a time trend, expressing a constant Hicks neutral technological change.

According to the table 6-7, and the equation 6-1, the model was chosen to express that the production function of the Libyan agricultural sector is statistical significance for all parameters estimated. The $R - Square$ of estimation is highly close to one, indicating a very good fit of the model, it also shows that the dependent variables explain the gain of 94% of the changes in the value of agricultural production. The F test is used to test the overall significant of a regression, in order to find out whether the explanatory variables do actually have any significant influence on the dependent variable. The null hypothesis (H_0: that there is no relationship between the dependent and independent variables) is tested against the alternative hypothesis (H_1: that not all β_i are zero). The F statistics value indicates that the null hypothesis is rejected. The F statistics confirm that the estimation result of the model is globally significant at both 5% and 1%. $t-$ test also confirms the significance of the parameters estimated at the level of 5% and 1%. The value of the Durbin Watson $(D - W)$ coefficient at the level of 1% attests to the absence of an autocorrelation problem.

Economically, the function 6-1 gives a clear picture of the long-run relationship between production and its factors. It can be deduced from this function that there is a positive relationship between capital stock and labour, as well as the coefficient of technology and the growth in agricultural output. Therefore, the increase in agricultural output required to increase the combination of these factors or increase one of them can also be deduced.

Hence, the share of agriculture to gross domestic product grew by 0.65% when the factor inputs (labour, capital and technical progress) grew by 1%, this means that agriculture in Libya is characterized by decreased returns to scale. The results of this function also show that capital stock is the most important factor affecting the share of agriculture to Libyan gross domestic product; when it increases by 1% with the stability of other factors, domestic agricultural production increases by 0.46%, while with an increase of labour input by 1%, agricultural output would increase by 0.18%. Also from the equation 6-1 it is clear that the rate of technical progress has a positive relationship with agricultural output; its contribution to output growth rate is about 1.6%.

6-5. Measurement of average and marginal product of production factors in the Libyan agricultural sector:

To calculate the average and marginal productivity of production factors in the agriculture sector during the period covered, we should go back to the general form of equation 5-14. It is known that productivity is calculated by dividing GDP by the amount or value of production variable; hence the average product of labour can be calculated as follows:

$$AP_L = \frac{Q}{L}$$

Compensating the value of Q from the equation estimated, the following form (average productivity) can be obtained:

$$AP_L = \frac{AtK^{\beta_1}L^{\beta_2}\,e}{L}$$

$$AP_L = AtK^{\beta_1}L^{\beta_2-1}e \qquad (6\text{-}2)$$

Marginal productivity of labour can be calculated as follows:

$$MP_L = \frac{\Delta Q}{\Delta L}$$

Taking the partial derivative of the equation estimated after putting them in the form of C-D, we can obtain:

$$MP_L = \beta_2 AtK^{\beta_1}L^{\beta_2-1}e \qquad (6\text{-}3)$$

From equations 6-2 and 6-3 the following relationship can be obtained:-

$$MP_L = \beta_2 AP_L \qquad (6\text{-}4)$$

where MP_L and AP_L are the marginal and average productivity of labour respectively. The marginal and average productivity of capital are calculated by the same method. Table 6-8 and figures 6-1 and 6-2 show the marginal and average productivity of labour and capital in the Libyan agricultural sector during the period of study.

Table 6-8

The average and marginal productivity of production variables in agriculture sector over the period 1970-2008

The value in million LD.

year	*Elasticity value of capital (0.46)*		*Elasticity value of labour (0.18)*	
	MP_K	AP_K	MP_L	AP_L
1970	0.11	0.25	0.11	0.64
1971	0.11	0.25	0.11	0.64
1972	0.10	0.22	0.13	0.73
1973	0.08	0.18	0.15	0.88
1974	0.07	0.15	0.19	1.05
1975	0.06	0.13	0.21	1.18
1976	0.06	0.13	0.22	1.24
1977	0.05	0.12	0.23	1.29
1978	0.05	0.12	0.24	1.34
1979	0.05	0.12	0.23	1.32
1980	0.05	0.12	0.24	1.35
1981	0.05	0.12	0.25	1.40
1982	0.05	0.12	0.24	1.38
1983	0.05	0.12	0.24	1.35
1984	0.06	0.13	0.22	1.26
1985	0.06	0.14	0.23	1.30
1986	0.06	0.14	0.23	1.30
1987	0.06	0.14	0.23	1.30
1988	0.07	0.15	0.22	1.27
1989	0.07	0.15	0.22	1.27
1990	0.07	0.16	0.23	1.28
1991	0.08	0.17	0.22	1.23
1992	0.08	0.19	0.20	1.14
1993	0.09	0.20	0.20	1.12
1994	0.10	0.22	0.18	1.04
1995	0.11	0.24	0.17	0.96
1996	0.12	0.26	0.16	0.91
1997	0.12	0.28	0.16	0.89
1998	0.11	0.25	0.17	0.97
1999	0.12	0.27	0.16	0.92
2000	0.12	0.27	0.17	0.95
2001	0.10	0.22	0.34	1.91
2002	0.08	0.18	0.42	2.35
2003	0.08	0.17	0.47	2.64
2004	0.07	0.17	0.48	2.66
2005	0.07	0.16	0.48	2.69
2006	0.07	0.16	0.48	2.71
2007	0.06	0.14	0.82	4.58
2008	0.06	0.14	1.05	5.86
Average	***0.08***	***0.18***	***0.27***	***1.55***

Figure 6-1): the average and marginal productivity of labour input in the Libyan agricultural sector.

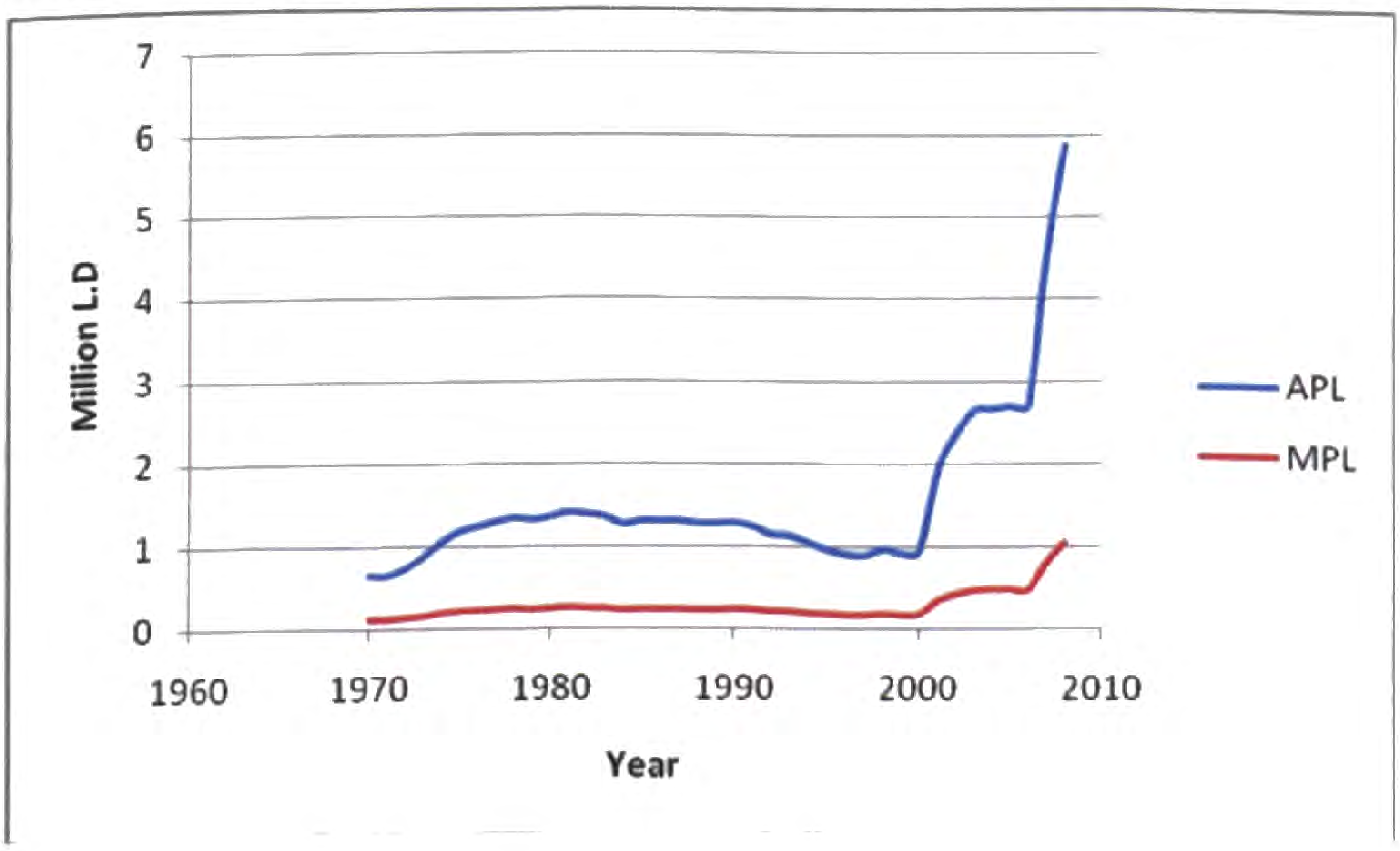
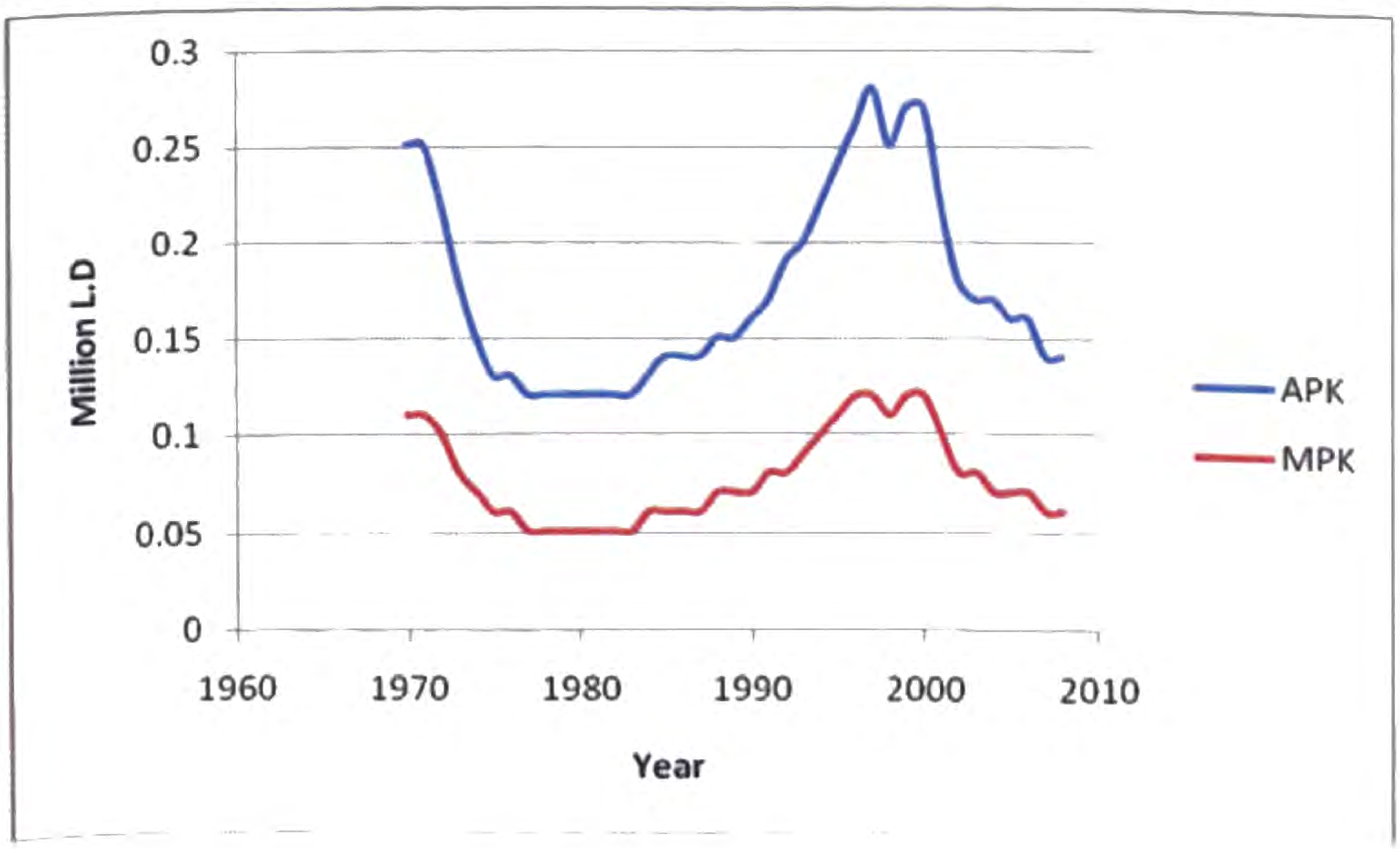


Figure 6-2: the average and marginal productivity of capital input in the Libyan agriculture sector.



From the table and figures it is noted that:-

- There was an increase in the marginal and average productivity of labour factor throughout the study period with the exception of the period 1983-1999. This decrease in the productivity of the labour input in the above period may have been due to the decline in output caused by a sharp increase in the number of workers during that time. Average productivity of labour also declined during the period 1995-1999 and then began to increase. This increase was not attributable to an increase in agricultural production, however, but rather because of the preference of workers to move to other productive sectors such as the oil sector, as well as to public services.

- Marginal and average productivity of the capital factor showed a marked decrease during the study period, with the exception of the period 1995-2000 when the marginal and average productivity of capital grew. This increase may have been caused by the country following a policy of reducing public expenditure during this period, which coincided with the economic embargo crisis. Then the marginal productivity of the factor began to decline again because of the increase in public spending on most sectors of the country over the period 2001-2008, due to improved international oil prices.

- It is clear that the agriculture sector in Libya has not reached the level of full employment for the production factors, due to the fact that agricultural production has been on the increase while using larger units of production inputs.
- Marginal productivity of labour and capital are less than the average productivity, this due to the fact that the elasticity of these factors is less than one.

- Table 6-8 and the figure 6-1 also show that the highest level of labour productivity was in 2008. This was not only as a result of an increase in agricultural output, but also because of a decline in the number of workers employed in agriculture at that time.

6-6. Estimation results of manufacturing production functions:

The Constant Elasticity of Substitution (CES) production function and Cobb-Douglas (C-D) production function have also been estimated, in order to highlight the relative importance of factor inputs and of technical progress on economic growth in the Libyan manufacturing sector over the period 1970-2008. The OLS method has been used to estimate the production functions using the absolute value of variables. The two functions are estimated with restriction and non-restriction of Constant Returns to Scale (CRS), and under both specifications of constant and variant Hicks natural technical progress.

Tables 6-9 and 6-11 show the estimation results of the CES and C-D production functions respectively, using the absolute value of variables. The unrestricted specification of CRS is provided in the first seven columns, and the restricted are provided in the last six columns of the same tables. From the tables $T-test$ values are mostly significant at 5% and 1%, indicating the rejection of the null hypothesis. The coefficient of determination ($R-Square$) of all functions is highly close to one, indicating a very good fit of the model. However, the Durbin Watson $(D-W)$ values are very low for most equations, indicating the presence of an autocorrelation problem in the error term in most of the cases, so that it is necessary that other methods should be used. 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 (Koutsoyiannis, 1993).

There are many methods which can be used as a solution for this problem, such as the use of a lag of the dependent variables as an explanatory variable, or using the first difference between the observation of variables instead of its absolute values, or the use of an autoregressive model, or including variables which seem to be important to the equations. Another problem that deserves to be mentioned is the strange behaviour of figures for the growth rate of output in the Libyan economy which is observed, especially in the period 1973-1974, 1982, 1992-2002 and 2000-2008, where output seems to have caused fluctuation in growth rates in those periods. However, to take these fluctuations in account, four dummy variables are included in the production functions.

The C-D and CES have been estimated with their different forms as defined in equations 5-12, 5-13, 5-15 and 5-16. The estimation results using the absolute value of variables are displayed in tables 6-9 and 6-11, where table 6-9 refers to the result of the CES estimation, while the result of estimation of the C-D production function is presented in table 6-11. .

The estimation results after adding the dummy variables show that the value of Durbin Watson $(D-W)$ has improved, indicating the elimination of the autocorrelation problem. Further, the findings indicate that most of the parameters of the variables used in the estimation process are statistically significant, this is clear from the value of $t-test$. The $F-test$ values are also significant in all the equations estimated at the level of 5% and 1%, indicating the rejection of the null hypothesis. The value of $R-square$ has also increased from its previous level, indicating a close relationship between the independent and dependent variables.

Since choosing the consistently appropriate function for the Libyan manufacturing sector is the main aim in this study, dealing with the estimation results of the CES function will be the first step in this section, and the results are tabled in 6-9.

The table summarizes the estimation results of the CES production function by using Kmenta approximation; from the table, the coefficient values of $\Delta(\ln K - \ln L)^2$ are not significantly different from zero, implying the C-D function should be employed in the manufacturing sector. None of the coefficient values of the CES are significant except for equations 6 and 7 on the left side of the table.

Table (6-9)

Estimation of the CES production function, using the absolute value of variables under both specifications of Constant and Variant Hicks neutral technical progress, and under the restriction of Constant and Variable Returns to Scale, specific to the Libyan manufacturing sector.

	Variable Returns to Scale (VRS)									Constant Returns to Scale (CRS)					
Equations	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**1**	**2**	**3**	**4**	**5**	**6**
Variables															
Constant	1.26 (4.01)***	0.66 (1.48)*	0.89 (2.58)***	1.05 (2.42)***	1.00 (2.26)**	-0.71 (-1.33)*	0.22 (0.70)			-0.68 (-2.43)***	0.02 (0.14)	-0.25 (-1.20)	-0.09 (-0.24)	-0.09 (-0.38)	-0.28 (-1.5)*
$\ln K$	0.10 (0.57)	0.26 (1.37)*	0.24 (1.35)*	0.29 (1.65)*	0.29 (1.64)*	0.64 (3.90)***	0.51 (3.43)***								
$\ln L$	0.54 (3.44)***	0.58 (3.54)***	0.52 (3.20)***	0.34 (2.01)**	0.36 (2.07)**	0.47 (3.30)***	0.34 (2.49)***								
$\ln(K/L)$										0.47 (1.75)**	0.42 (2.5)***	0.57 (2.9)***	0.49 (2.66)***	0.47 (2.59)	0.57 (4 20)***
$(\ln K - \ln L)^2$	0.08 (2.38)**	0.04 (1.06)	0.04 (1.16)	0.06 (1.59)*	0.06 (1.56)*	-0.01 (-0.51)	0.004 (0.12)			0.03 (0.66)	0.007 (0.21)	-0.02 (-0.58)	-0.001 (-0.03)	0.002 (0.07)	0.002 (0.10)
t		-0.01 (-1.83)**			0.0007 (0.10)	-0.03 (-3.4)***					-0.01 (-7.62)***		-0.01 (-7.39)***	-0.01 (-7.37)***	-0.02 (-11.4)***
t^2			-0.0001 (-2.09)**				-0.0005 (-3.3)***					-0.0004 (-6.0)***			
D_1				0.20 (2.72)***	0.20	0.22 (3.51)***	0.19 (2.86)***						0.05 (0.88)	0.05 (0.89)	0.24 (4 16)***
D_2															
D_3					-0.08 (-0.69)	-0.16 (-1.75)**	-0.12 (-1.35)*							-0.14 (-1.15)	-0.14 (-1.58)*
D_4						0.39 (4.27)***	0.36 (4.16)***								0.33 (5.50)***
R^2	0.91	0.92	0.92	0.93	0.93	0.96	0.95			0.89	0.96	0.96	0.96	0.96	0.98
F	121.9	98.4	101.4	0.95	78.1	105.6	103.5			152.0	281.6	212.7	210.1	169.9	272.5
DW	0.83	0.91	0.92	1.09	1.06	1.79	1.60			0.33	0.86	0.65	0.83	0.83	1.66

Figures in the brackets are the $t-\text{value}$, **** significant at the 1% level; **significant at the 5% level; * significant at the 10% level.*

t *refers to constant rate of technical progress.*

t^2 *refers to variable rate of technical progress.*

$\ln Q$ *and* $\ln(Q/L)$ *as dependent variables for the unrestricted and the restricted specification respectively.*

Function 6 on the left (VRS) side of table 6-9 is used to calculate the parameters of the CES production function, which are summarized in table 6-10. According to equation 6 and table 6-10, the ρ value is not significantly different from zero, leading to the unitary elasticity of substitution between factor inputs ($\sigma = 0.94$) is close to one), this further confirms that using the C-D production function as a best fit for the Libyan manufacturing sector.

Table 6-10: estimation result of CES parameters of the Libyan manufacturing sector.

Variables	*Coefficient values*
A	0.84
ε	1.11
ρ	0.07
σ	0.94

Estimation results of the C-D production function using the absolute value of variables are presented in table 6-11. The left side of the table show the estimation results of the equations under the assumption of Variable Returns to Scale (VRS), while the right side of the table shows the estimation results of the equations under the assumption of Constant Returns to Scale (CRS). The C-D production function is also estimated with variant and constant Hicks neutral technical progress specifications.

The Ordinary Least Square (OLS) method is used to estimate the C-D function in the Libyan manufacturing sector, over the period covered by the study. All variables in the estimation process are expressed in 1980 base year pricing. Among the different estimated equations, the C-D form with constant Hicks neutral technical progress specification 5-15, which is presented in table 6-11, is a well specified equation, and that which best fits the Libyan manufacturing data.

Table (6-11)

Estimation of the ***C-D*** *production function, using the absolute value of variables under both specifications of Constant and Variant Hicks neutral technical progress, and under the restriction of constant and variable Returns to Scale, specific to the Libyan manufacturing sector.*

	Variable Returns to Scale (VRS)									Constant Returns to Scale (CRS)					
Equations	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6
Variables															
Constant	0.76 (3.06)***	0.29 (1.04)	0.59 (2.57)***	0.51 (1.84)**	0.46 (1.66)*	0.42 (1.48)*	-0.50 (1.63)*	-0.49 (-1.64)*	0.19 (0.99)	-0.85 (-8.9)***	-0.004 (-0.03)	-0.15 (-1.19)	-0.09 (-0.58)	-0.10 (-0.68)	-0.29 (-2.51)***
$\ln K$	0.51 (16.8)***	0.46 (13.80)***	0.46 (13.12)***	0.56 (11.06)***	0.56 (10.98)***	0.56 (10.86)***	0.56 (13.9)***	0.56 (14.1)***	0.53 (11.7)***						
$\ln L$	0.18 (5.38)***	0.43 (4.71)***	0.34 (5.63)***	0.17 (1.28)	0.18 (1.36)*	0.20 (1.43)*	0.50 (3.92)***	0.50 (3.95)***	0.33 (3.59)***						
$\ln(K/L)$										0.65 (17.5)***	0.45 (13.7)***	0.46 (11.3)***	0.48 (11.0)***	0.49 (11.1)***	0.58 (16.26)***
$(\ln K - \ln L)^2$															
t		0.01 (2.87)***		0.004 (0.68)	0.004 (0.68)	0.005 (0.78)	0.03 (4.09)***	0.03 (4.21)***			0.01 (7.80)***		0.02 (7.52)***	0.02 (7.51)***	-0.02 (-11.6)***
t^2			-0.0002 (-3.03)***						-0.0005 (-4.1)***			-0.0004 (-6.1)***			
D_1				0.18 (2.44)***	0.18 (2.41)**	0.18 (2.29)**	0.22 (3.57)***	0.22 (3.63)***	0.19 (2.91)***				0.05 (0.92)	0.05 (0.96)	0.24 (4.35)***
D_2					0.059 (0.93)	0.05 (0.87)	0.03 (0.59)								
D_3						-0.07 (-0.63)	-0.15 (-1.63)*	-0.16 (-1.72)**	-0.12 (-1.38)*					-0.14 (-1.16)	-0.14 (-1.60)*
D_4							0.36 (4.58)***	0.36 (4.72)***	0.37 (4 67)***						0.33 (5.59)***
R^2	0.90	0.91	0.91	0.93	0.93	0.93	0.96	0.96	0.96	0.89	0.96	0.95	0.96	0.96	0.98
F	159.2	130.3	133.4	113.1	90.3	74.0	106.0	126.1	124.6	308.2	433.9	324.8	288.3	218.7	337.1
DW	0.70	.87	0.87	0.99	1.02	0.99	1.74	1.74	1.61	0.33	0.85	0.65	0.83	0.84	1.66

Figures in the brackets are the $t-\text{value}$*, *** significant at the 1% level; **significant at the 5% level; * significant at the 10% level.*

t *refers to constant rate of technical progress.*

t^2 *refers to variable rate of technical progress.*

$\ln Q$ *and* $\ln(Q/L)$ *as dependent variables for the unrestricted and the restricted specification respectively.*

Equation 8 in Table 6-11, employing the C-D production function with a constant form of Hicks neutral technical change, was adopted because it gives the best results, it is written as follows:-

$$\ln Q = -0.49 + 0.56 \ln K + 0.50 \ln L + 0.03t + 0.22D_1 - 0.16D_3 + 0.36D_4 \qquad (6\text{-}5)$$

$T-values$ (−1.64) (14.1) (3.95) (4.21) (3.63) (−1.72) (4.72)

$R^2 = 0.96$ $F = 126.1$ $D-W = 1.74$

Where $\ln Q$ is the natural logarithm of manufacturing output, $\ln K$ and $\ln L$ are the natural logarithm of capital stock and number of workers in the sector respectively. t indicates time trend, expressing a constant Hicks neutral technological change. D_1, D_3 and D_4 are dummy variables as represented previously.

According to table 6-11, and equation 6-5, the model chosen to express the production function of the Libyan manufacturing sector is statistically significant for all parameters estimated; this was clear from the value of the t statistic at the level of 5% and 1%. The $R-square$ of estimation is highly close to one, indicating a good fit of the model, it also shows that the independent variables explain the gain of 96% of the changes in the value of manufacturing production. The F statistics confirm that the estimation result of the model is globally significant at the level of 5% and 1%, indicating a linear relationship between endogenous and exogenous variables. The value of the Durbin Watson $(D-W)$ coefficient at level of 1% proves the absence of an autocorrelation problem.

Economically, function 6-5 gives a clear picture of the long-run relationship between production and its factor inputs. From this function a positive relationship between capital stock and labour, as well as the coefficient of technology and the growth in manufacturing output, can be deduced. Therefore, the increase in manufacturing output required to increase the combination of these factors (capital, labour and technical progress), or increase one of them, can also be deduced.

Therefore, the contribution of manufacturing to gross domestic product grew by 1.06%, while factor inputs (capital and labour) grew by 1%; this means that the manufacturing sector in Libya is characterized by constant returns to scale, which also confirms the adoption of the C-D function. The results of this function also show that capital stock is the most important factor affecting gross domestic product in the Libyan manufacturing sector: when it increases by 1% with the stability of other factors, the domestic manufacturing production will increase by 0.56%, while with an increase of labour input by 1%, the manufacturing output would increase by 0.50%. Also from the equation it is clear that the rate of technical progress has a positive relationship with manufacturing output; its contribution to output growth rate is about 3%. The coefficient of the parameters of dummy variables indicates that the change in output of the Libyan manufacturing sector has a positive relationship with D_1 and D_4, this indicate that the output of this sector improved in the embargo period (1992-2002) and in the period 2002-2008. There was no improvement in 1982 (a boom year), and this confirms the inverse effect of the oil sector on the productive sectors in Libya. The right side of table 6-11 shows the estimation result of C-D under the restriction of CRS. Function 6 is the best to explain the relationship between capital-labour ratio and per capita income in the Libyan manufacturing sector. From the equation is clear that an increase in capital-labour ratio by 1% leads per capita income to increase by 0.58%. This is identical to economic theory.

6-7. Measurement of average and marginal product of production factors in the Libyan manufacturing sector:

The average and marginal product of the factors used to produce the output in the manufacturing sector have been calculated for the period 1970-2008. Equations 6-2 and 6-3 are also applied to calculate the average and marginal product of factors respectively. Table 6-12 and figures 6-3 and 6-4 show:-

- The fluctuating value of marginal and average productivity of labour input during the period of study, whereby it can be noted from the table and the figures that marginal and average productivity started to increase in the first years, and reached their highest value in 1977, then began to decline; this could be due to the fact that the rate of increase of the number of workers was greater than the rate of increase in the output of the manufacturing sector. The values of marginal and average product of labour continued to decline until the year 2001. This can also be attributed to the a reduction in the importance placed by the Libyan government on this sector, especially in the period of the nineties, which is reflected in a reduction in public expenditure on this sector, which reached zero in 1997. External economic and political factors also had an impact on the manufacturing sector, which is clear from the value of marginal and average productivity during the period 1992-2002 (the period of economic blockade). During this period the industrial sector saw significant decline in the marginal and average productivity of its factors. The decline here was because the Libyan manufacturing sector depended on imports for most industrial equipment and semi-manufactured goods from abroad.

- The average and marginal product of labour increased during the period 2002-2008. This increase was not due to an increase in output of the manufacturing sector, but because of the decline in the number of workers employed in this sector in that time.

- Marginal and average productivity of capital input began to decline until 1991 and then increased up to 2002, and then declined again. Decline of productivity during the periods 1970-1991 and 2002-2008 was due to the large-scale investment of capital during these periods resulting in low marginal productivity, unlike the period 1992-2002, which was marked by an increase of marginal and average productivity because the government reduced public spending on most sectors due to lower oil revenues during the economic blockade.

- It is noted that the manufacturing sector in Libya has also not reached the level of full employment for production factors; this is clear from the fact that manufacturing production increased when larger units of production inputs were used.
- Marginal productivity of labour and capital are also less than average productivity, this is due to the fact that the elasticity of these factors is less than one.
- The average and marginal product of capital input declined during the period 2000-2008: this may be due to several reasons including the significant increase in oil prices and increased oil exports during this period. All these elements led to an increase in public spending. This also resulted in a decline in the productivity of capital at that time,

- The table 6-12 and the figure 6-3 also show that the highest level of labour productivity was in 1977.

Table 6-12

The average and marginal productivity of production variables in manufacturing sector over the period 1970-2008

The value in million LD

year	*Elasticity value of capital (0.56)*		*Elasticity value of labour (0.50)*	
	MP_K	AP_K	MP_L	AP_L
1970	0.15	0.28	1.4	2.8
1971	0.13	0.23	1.1	2.3
1972	0.12	0.21	1.5	3.0
1973	0.11	0.20	1.9	3.8
1974	0.09	0.16	2.0	4.0
1975	0.08	0.14	2.0	4.0
1976	0.084	0.15	2.2	4.4
1977	0.09	0.16	2.4	4.9
1978	0.09	0.16	2.2	4.5
1979	0.09	0.16	2.0	4.1
1980	0.07	0.13	1.8	3.6
1981	0.06	0.12	1.9	3.8
1982	0.06	0.11	1.5	3.1
1983	0.06	0.12	1.5	3.1
1984	0.06	0.11	1.7	3.4
1985	0.07	0.12	1.7	3.5
1986	0.05	0.10	1.4	2.8
1987	0.05	0.09	1.2	2.4
1988	0.06	0.11	1.3	2.6
1989	0.06	0.12	1.2	2.5
1990	0.07	0.13	1.1	2.3
1991	0.08	0.14	1.0	2.1
1992	0.09	0.17	1.0	2.1
1993	0.12	0.22	1.0	2.0
1994	0.11	0.19	0.66	1.3
1995	0.13	0.24	0.62	1.2
1996	0.12	0.22	0.48	0.96
1997	0.15	0.27	0.40	0.81
1998	0.15	0.27	0.42	0.84
1999	0.17	0.31	0.39	0.78
2000	0.21	0.38	0.44	0.80
2001	0.19	0.34	0.64	1.2
2002	0.15	0.28	0.64	1.2
2003	0.13	0.23	0.60	1.2
2004	0.11	0.21	0.59	1.1
2005	0.10	0.19	0.58	1.1
2006	0.09	0.17	0.57	1.1
2007	0.08	0.15	0.55	1.1
2008	0.07	0.14	0.50	1.0
Average	***0.10***	***0.19***	***1.21***	***2.40***

Figure 6-3: the average and marginal productivity of labour input in the Libyan manufacturing sector during the period 1970-2008.

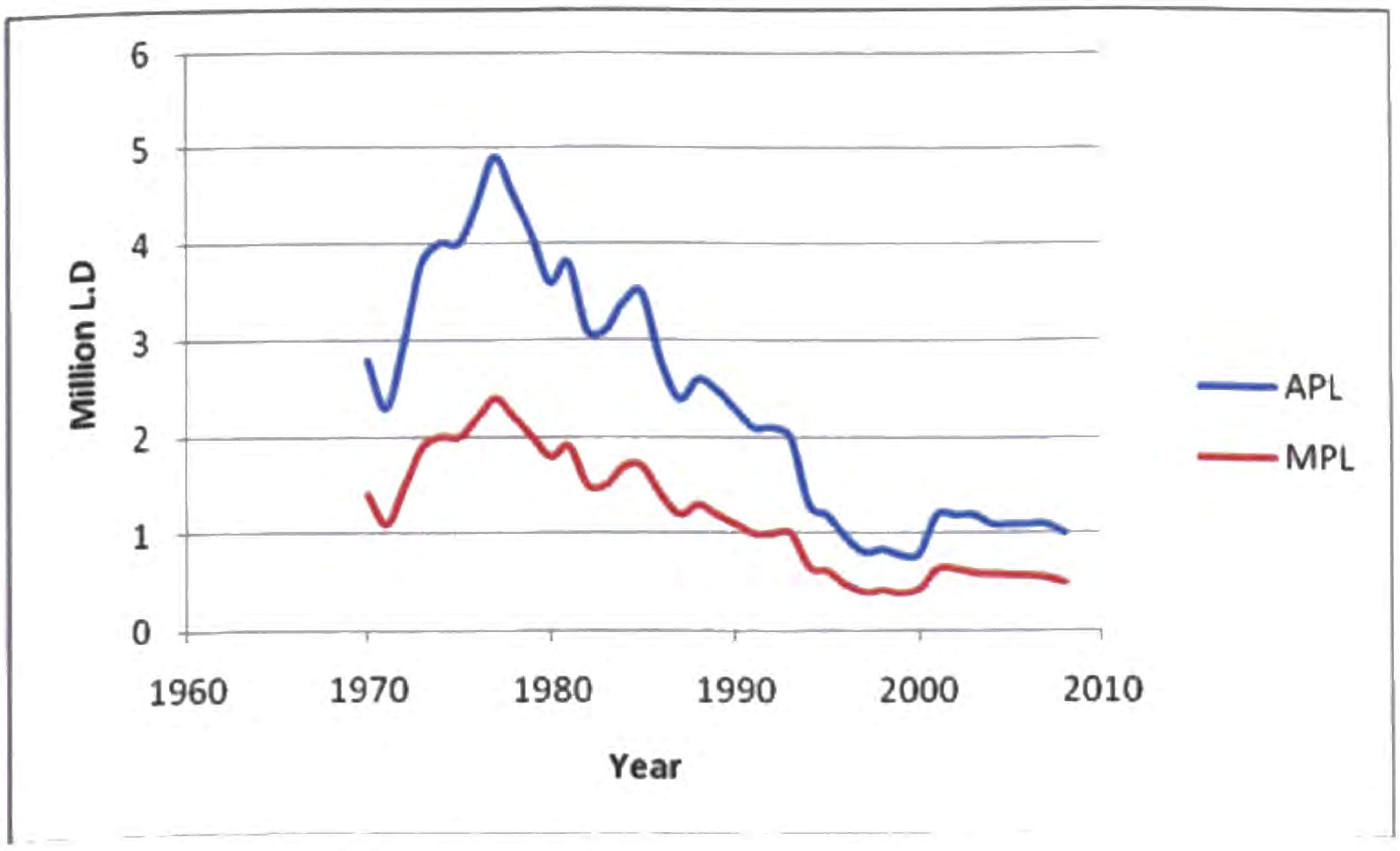
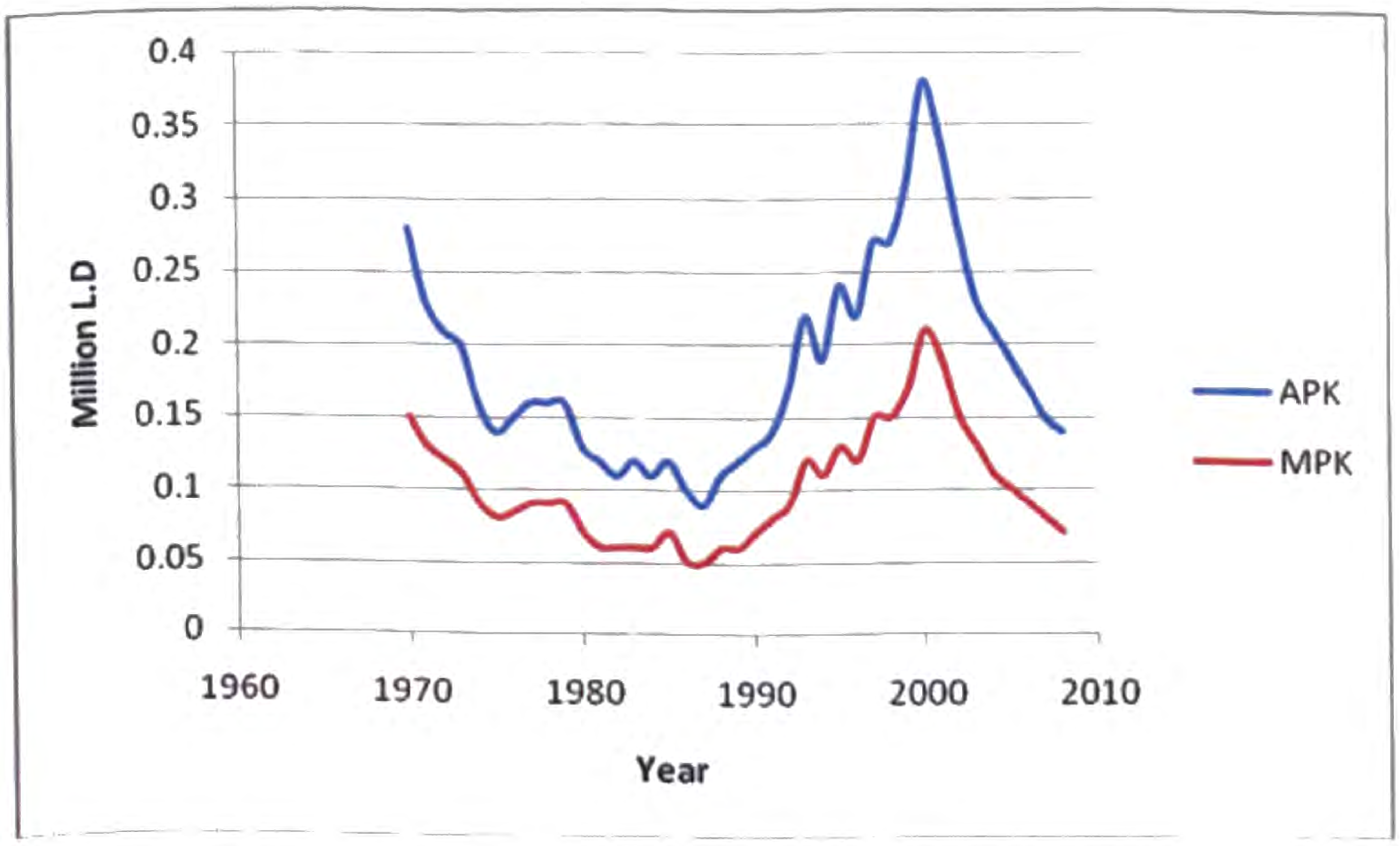


Figure 6-4: the average and marginal productivity of capital input in the Libyan manufacturing sector during the period 1970-2008.



6-8. *Conclusion:*

This chapter is a preliminary attempt to specify and estimate a sector production function for two commodity sectors of the Libyan economy: agriculture and manufacturing, depending on the availability of data on capital stock and number of workers, using the two widely adopted functions: Cobb-Douglas (C-D) and Constant Elasticity of Substitution (CES).

To avoid facing some of the econometric problems of an estimation process, such as the spurious regression problem, the unit roots test and co-integration test were the first step in our regression process. The DF and ADF are used to test the stationary of variables used in the regression. The Johansen-Juseliues co-integration approach is used in this study because it is the most commonly employed in the literature and because this study includes more than two variables. According to the above tests, the DF and ADF indicate an acceptance of the null hypothesis of unit roots with using the absolute value (level) of variables of the agriculture, manufacturing and productive sectors. However, the null hypothesis was rejected in this case when using the first difference of value of variable, confirming the possibility of using the first difference of the observation of the variables.

The co-integration test of Johansen-Juseliues (1988) is used and the results refer to the possibility of using the level of variables integrated at the same rank in the regression for all specifications (as in the case of the Libyan agriculture, manufacturing and productive sectors). In order to determine the relative importance of production factors and of technical progress on the economic growth of the agriculture and manufacturing sectors, it is necessary to assess the preferable function to deal with the data in these sectors. The C-D and CES production function are estimated with and without restriction of Constant Returns to Scale (CRS) and with constant and variant Hicks neutral technical progress. The Ordinary Least Square (OLS) estimation of the log-linear Cobb-Douglass and CES production functions gives the following results:-

- The Cobb-Douglas production function is found to be the best fit function for the Libyan agriculture and manufacturing sectors.

-Labour, capital and time (time variable as a proxy for disembodied technical progress) are significant explanatory variables in the two sectors. Economic growth of agricultural and manufacturing has been positively affected by the technical progress, but its effect was relatively small, this indicated by a low elasticity of output with respect to technical progress.

- Production in the agricultural sector exhibits decreasing returns to scale: the sum of the two estimated coefficients of labour and capital is less than one. On the other hand, production in the manufacturing sector exhibits constant returns to scale: the sum of the two estimated coefficient of labour and capital is equal to one.

- The contribution in GDP with respect to capital is higher than the contribution in output with respect to labour in both sectors, indicating that the economic growth of agriculture and manufacturing sectors are more responsive to change capital input.

- Dummy variables are added to the regression process, in order to take into account the fluctuations seen in the growth rate of output. The coefficient of dummy variables indicates that the periods 1992-2002 and 2002-2008 have a positive relationship with the growth rate of GDP in both sectors, while the period 1982 has a negative relationship.

CHAPTER SEVEN

An estimation of the production functions in the Libyan productive sector

7-1. Introduction:

In the previous chapter, the C-D and CES production functions were estimated in various forms for both the agriculture and industrial sectors separately, and the results show that the Cobb-Douglas production function is the appropriate function to deal with data in these sectors. The two forms of production function are estimated in this chapter, but in a different way from above; the data used in the estimation process is defined by variables collected from both the agriculture and industry sectors, forming one sector, which is the productive sector.

The value of contribution to gross domestic product (GDP) of this sector is the value of the contribution of the manufacturing sector plus the contribution of the agricultural sector; this is also the case with respect to labour and capital inputs. Agriculture and manufacturing have been selected to represent the Libyan productive sector, because these sectors are the main productive sectors targeted by Libyan development plans. They have also attracted significant interest from the government during the study period. Most investment has been directed to these sectors (as noted in chapter two) in order to diversify the local economy and to encourage alternative sources of income in addition to oil.

This chapter contains an estimation of the long-run relationship between endogenous and exogenous variables in the productive sectors, using both C-D and CES production functions in their different forms: this process is outlined in section 7-

2, while section 7-3 contains the result of the estimation. The measurement of marginal and average productivity of estimated variables is presented in section 7-4. This chapter also contains analysis of the ability of the estimated model to predict reality, using some statistical tests, such as historical simulation, as well as Theil's inequality test, as referred to in sections 7-5 and 7-6. Lastly, the conclusion of this chapter is presented in section 7-7.

7-2 Estimating production functions in the Libyan productive sector:

To answer the research questions of which is the preferable function for dealing with data in the Libyan productive sectors, the C-D and CES have been estimated , in order to investigate which one is more suitable to explain the long-run relationship between exogenous and endogenous variables. The contribution to gross domestic product (GDP) of the productive sector is the contribution of the manufacturing sector plus the contribution of the agricultural sector, and this is also the case with respect to labour and capital inputs. The total of employment used in this study is expressed by the total number of workers in agriculture and industry, also the capital input is the net of total capital stock in both sectors.

The C-D and CES production functions have been estimated differently from the previous chapter, because some studies have found that the appropriate form of the function may depend sometimes on the type of sector.

Salem (2004) found in his study of the Tunisian economy that the C-D was suitable for agriculture, fishing, and clothing and leather sectors, while the CES form was suitable for the oil and gas sectors and the transport and telecommunication sector.

The C-D and CES production functions are estimated using the specifications detailed in sections 5-12, 5-13, 5-15 and 5-16.

7-3. Estimation results:

After testing the time series of all the production variables used in estimating the production function in the Libyan productive sector, using both DF and ADF tests and the co-integration test, the results were presented in tables 6-1 and 6-3 (in the previous chapter). The tables show that the variables used in the estimation process are stationary at their first difference, and the time series of these variables are integrated at the first rank.

The CES and C-D were estimated using the absolute value of variables, and in their different specification, as in sections 5-12, 5-13, 5-15 and 5-16, in order to investigate the relative importance of factor inputs and of technical progress on economic growth in the Libyan productive sectors, and to measure the elasticity of substitution between the factors, to determine the best fit production function for this sector.

The C-D and CES functions have been estimated with restriction and non-restriction of Constant Returns to Scale (CRS), and with both specifications of constant and variant Hicks neutral technical progress. The data are: time series of output value; number of workers; and net capital stock of the Libyan productive sectors, during the period 1970-2008. All variables in the estimation process are expressed in 1980 base year pricing.

The C-D and CES were estimated using the absolute value of variables, and the results are presented in table 7-1. The unrestricted specification of CRS is provided in the first eight columns, and the restricted specification of CRS is provided in the last six columns of the same tables. The results show that $T-test$ values are mostly significant at 5% and 1%, indicating the rejection of the null hypothesis, meaning that all parameters of variables are significant. The coefficient of determination ($R-Square$) of all functions is highly close to one, indicating the ability of independent variables to explain the change in output; (i.e. there is a linear relationship between exogenous and endogenous variables). F values are also significant at 1% and 5%, indicating a very good fit for the model.

The Durbin Watson ($D-W$) values are very low for some equations, indicating the existence of an autocorrelation problem. However, adding dummy variables to the estimated equations led to an improvement of the value of $D-W$. The value of the latter was improved in the case of equations 4, 5, 6, 7, and 8 in the left side of the table and in the case of equation 6 in the right side of the same table.

Table (7-1)

Estimation of the CES production function, using the absolute value of variables under both specifications of Constant and Variant Hicks neutral technical progress, and under the restriction of constant and variable Returns to Scale, specific to the Libyan productive sector.

	Variable Returns to Scale (VRS)									Constant Returns to Scale (CRS)					
Equations	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**1**	**2**	**3**	**4**	**5**	**6**
Variables															
Constant	-1.14 (-2.6)***	-0.14 (-0.38)	-0.56 (-1.65)*	0.34 (1.00)	0.31 (0.92)	0.33 (0.92)	-0.14 (-0.33)	-0.14 (-0.34)		-1.25 (-6.56)***	-1.23 (-6.8)***	-1.28 (-6.5)***	-1.25 (-6.4)***	-1.25 (-6.3)***	-1.11 (-7.17)***
$\ln K$	1.08 (4.38)***	0.86 (4.59)***	0.93 (4.96)***	0.79 (4.86)***	0.77 (4.70)***	0.77 (4.63)***	0.79 (4.86)***	0.79 (4.95)***							
$\ln L$	-0.09 (-0.37)	-0.04 (-0.23)	-0.03 (-0.19)	-0.06 (-0.44)	-0.03 (-0.23)	-0.04 (-0.25)	0.03 (0.21)	0.03 (0.22)							
$\ln(K/L)$										1.03 (5.02)***	1.02 (5.29)***	1.04 (5.0)***	0.99 (4.77)***	0.99 (4.65)***	0.88 (5.29)***
$(\ln K - \ln L)^2$	-0.14 (-2.30)**	-0.09 (-1.92)**	-0.10 (-2.20)**	-0.05 (-1.38)*	-0.05 (-1.25)	-0.05 (-1.24)	-0.05 (-1.34)*	-0.05 (-1.36)*		-0.12 (-2.45)***	-0.12 (-2.5)***	-0.12 (-2.38)**	-0.11 (-2.15)	-0.11 (-2.07)**	-0.07 (-1.85)**
t		0.01 (5.36)***		0.01 (5.51)***	0.01 (5.65)***	0.01 (5.54)***	0.002 (0.94)	0.002 (0.95)		0.004 (3.64)***		0.003 (2.7)***	0.004 (3.09)***	0.004 (3.00)***	-0.002 (-1.22)
t^2			0.0001 (5.21)***								0.0001 (4.45)***				
D_1				0.14 (3.58)***	0.13 (3.50)***	0.13 (3.45)***	0.14 (3.68)***	0.14 (3.74)***				0.03 (0.79)	0.03 (0.78)	0.03 (0.78	0.11 (2.95)***
D_2					0.04 (1.16)	0.04 (1.16)	0.03 (1.12)	0.03 (1.13)					0.06 (1.39)*	0.06 (1.34)*	0.04 (1.21)
D_3						0.01 (0.22)	0.004 (0.07)							-0.01 (-0.22)	
D_4							0.09 (1.69)**	0.09 (1.73)**							0.18 (4.61)***
R^2	0.93	0.96	0.96	0.97	0.97	0.97	0.97	0.98		0.94	0.95	0.94	0.94	0.94	0.97
F	164.8	228.9	223	249.6	210.5	175.1	162.8	192.2		196.0	224.1	145.6	120.1	97.2	165.2
DW	0.80	1.35	1.35	1.77	1.88	1.88	2.14	2.15		1.11	1.24	1.07	1.22	1.23	2.17

Figures in the brackets are the $t-value$, *** significant at the 1% level; **significant at the 5% level; * significant at the 10% level.

t refers to constant rate of technical progress.

t^2 refers to variable rate of technical progress.

$\ln Q$ and $\ln(Q/L)$ are dependent variables for the unrestricted and the restricted specification respectively.

Table 7-1 provides the estimation results of the CES production function. The Kment approximation is used to estimate the CES form. The result in table 7-1 shows that specifications of constant returns to scale (CRS), which are shown on the right side of the table, are mostly significant. However, the values of $D-W$ are still very low, indicating to existence of an autocorrelation problem. Equation 8 in table 7-1 is the best that can be chosen in order to calculate the parameters of the CES production function. The parameters of the CES production function are summarized in table 7-2.

Table (7-2): Estimation result of the CES parameters of the Libyan productive sector

Variables	*Coefficient values*
A	0.84
ε	0.82
ρ	4
σ	0.20

According the table 7-2 and equation 8 in table 7-1, the ρ value does differ from zero ($\rho = 4$) indicating that the elasticity of substitution between capital and labour factors is not equal to one, this indicates the possibility of using the CES form to explain any change in economic growth in the Libyan productive sector. However, the coefficients of labour and of technical progress are not significant; this led to select the Cobb-Douglas production function as the best which can be chosen. This result is compatible with the results of studies by Whitesell (1985), Sadeg (1996), Sahin (2003) and Minh and Long (2008).

Estimation results of the C-D production function using the absolute value of variables of long-run time series are presented in table 7-3. The right side of the table shows the estimation result of the equation under restriction of Constant Returns to Scale (CRS), while the left side of the table shows the estimation result of the function under the restriction Variant Returns to Scale (VRS). From the table most equations, especially those which included dummy variables, are statistically significant and equation 4 is the best that can be chosen.

One of the aims of the research is to determine which of the production factors (labour or capital) is more important in explaining the changes in economic growth of the Libyan productive sector. Equation 4 on the left side of table 7-3 has been chosen to explain the relative importance of factor inputs and of technical progress on economic growth in this sector. The equation with the specification of constant Hicks neutral technical progress has been adopted, because it is the best function to explain the effect of variable inputs on the change in output in the Libyan productive sector. The form of the equation is written as follows:-

$$\ln Q = 0.66 + 0.57 \ln K + 0.13 \ln L + 0.01t + 0.15 D_1 \qquad (7\text{-}1)$$

$$T-values \quad (2.49) \quad (23.2) \qquad (2.24) \qquad (5.72) \quad (3.93)$$

$$R^2 = 0.97 \qquad F = 303.3 \qquad D-W = 1.80$$

where $\ln Q$ is the value of the natural logarithm of GDP of productive sector, $\ln K$ and $\ln L$ are the value of the natural logarithms of capital stock and number of workers in the sector respectively. t indicates time trend expressing a constant Hicks neutral technological change. D_1 is a dummy variable.

According to table 7-3 and equation 7-1, the model which was chosen to express the production function of the Libyan productive sector is statistically significant for all parameters estimated at the level of 5% and 1%. The $R-Square$ of estimation is highly close to one, indicating a very good fit for the model, it also shows that the independent variables explain the gain of 97% of the changes in the value of production in the Libyan productive sector. The F statistics confirmed that the estimation result of the model is globally significant at the level of 5% and 1%. The value of the Durbin Watson $(D-W)$ coefficient at the level of 1% and 5% indicates the absence of an autocorrelation problem.

Economically, analysis of function 7-1 gives a clear picture of a long-run relationship between production and its factors. A positive relationship between capital and labour inputs on one side and GDP of productive sector on the other side in the productive sector can be seen, as well as the fact that the coefficient of technology has a positive impact on economic growth in the Libyan productive sector. Therefore, an increase in GDP in this sector requires an increase in a combination of these factors or increases in one of them. A growth in factor inputs (capital and labour) by 1% leads to a growth in the contribution to the GDP of the productive sector of 0.70%. This means that the productive sector in Libya is characterized by decreasing returns to scale. The results of this function also show that capital stock is the most important factor affecting growth in the contribution to GDP of the Libyan productive sector. When capital stock increases by 1% given the stability of other factors, the contribution to GDP will increase by 0.57%, while increasing labour input by 1% leads to GDP in the Libyan productive sector increasing by 0.13%. From the equation it is also clear that the rate of technical progress has a positive relationship with GDP in this sector; its contribution to the GDP growth rate is about 0.1%. The coefficient of the dummy variable indicates that the period of economic blockade had a positive impact on GDP in the Libyan productive sector.

Table (7-3)

*Estimation of the **C-D** production function, using the absolute value of variables under both specifications of Constant and Variant Hicks neutral technical progress, and under the restriction of Constant and Variable Returns to Scale, specific to the Libyan productive sector.*

	Variable Returns to Scale (VRS)								Constant Returns to Scale (CRS)						
Equations	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**		**1**	**2**	**3**	**4**	**5**	**6**
variables															
Constant	-0.53 (-1.52)*	0.30 (1.02)	-0.08 (-0.31)	**0.66** **(2.49)*****	0.59 (2.22)**	0.59 (2.18)**	0.15 (0.40)	0.15 (0.42)		-0.80 (-13.2)***	-0.79 (-14.5)***	-0.85 (-10.5)***	-0.86 (-10.9)***	-0.87 (-10.8)***	-0.85 (-13.6)***
$\ln K$	0.51 (17.7)***	0.50 (23.5)***	0.51 (23.6)***	**0.57** **(23.21)*****	0.56 (23.2)***	0.56 (22.6)***	0.57 (23.1)***	0.57 (23.7)***							
$\ln L$	0.45 (8.16)***	0.29 (5.8)***	0.36 (7.81)***	**0.13** **(2.24)*****	0.14 (2.47)***	0.14 (2.42)***	0.22 (2.94)***	0.22 (3.00)***							
$\ln(K/L)$										0.52 (22.5)***	0.53 (24.0)***	0.55 (16.2)***	0.55 (16.4)***	0.55 (16.1)***	0.57 (21.3)***
$(\ln K - \ln L)^2$															
t		0.01 (5.6)***		**0.01** **(5.72)*****	0.01 (5.93)***	0.01 (5.78)***	0.002 (1.06)	0.002 (1.10)		0.004 (3.61)***		0.003 (2.65)***	0.004 (3.12)***	0.004 (3.01)***	-0.002 (-1.35)*
t^2			0.0001 (5.33)***								0.0001 (4.36)***				
D_1				**0.15** **(3.93)*****	0.14 (3.82)***	0.14 (3.76)***	0.15 (3.99)***	0.15 (4.05)***				0.04 (0.91)	0.04 (0.89)	0.04 (0.91)	0.12 (3.11)***
D_2					0.04 (1.31)*	0.04 (1.29)	0.04 (1.25)	0.04 (1.28)					0.07 (1.67)*	0.07 (1.59)*	0.05 (1.34)*
D_3						0.006 (0.10)	-0.003 (-0.05)							-0.04 (-0.48)	-0.03 (-0.46)
D_4							0.08 (1.63)*	0.08 (1.65)*							0.19 (4.7)***
R^2	0.92	0.96	0.95	**0.97**	0.97	0.97	0.97	0.97		0.93	0.94	0.93	0.94	0.94	0.96
F	218.5	282.2	266.3	**303.3**	248.1	200.6	181.1	218.1		255.2	288.9	169.6	134.5	105.2	149.8
DW	0.83	1.36	1.34	**1.80**	1.88	1.87	2.12	2.12		1.13	1.25	1.08	1.23	1.26	2.22

Figures in the brackets are the $t - value$, *** significant at the 1% level; **significant at the 5% level; * significant at the 10% level.

t refers to constant rate of technical progress.

t^2 refers to variable rate of technical progress.

$\ln Q$ and $\ln(Q/L)$ are dependent variables for the unrestricted and the restricted specifications respectively

7-4. *Measurement average and marginal product of production factors in the Libyan productive sector:*

Equations 6-18 and 6-19, as mentioned in chapter six, may also be used to calculate the average and marginal productivity of production factors in the Libyan productive sector. Equation 6-18 is used to calculate the average product of both factors (labour and capital), while equation 6-19 is used to calculate the marginal product of the factors, where MP_L and MP_K are the marginal productivity of labour and capital respectively. AP_L and AP_K are the average productivity of labour and capital respectively.

Table 7-4 and figures 7-1 and 7-2 show the values of marginal and average productivity of labour and capital in the Libyan productive sectors during the period 1970-2008. From the table and figures, it can be noted that:

- There was a decrease in the marginal and average productivity of the capital input from the beginning of the study period until 1990. The reason for this is probably an increase in public spending during that period. The decrease in average productivity of capital during the same period was due to the use of more units of capital associated with the decline in the productivity of the productive sector in that period.

- Marginal and average productivity of labour input had begun to improve at the beginning of the study period, and then declined during the period 1992-2001; the latter period coincided with the economic embargo on Libya, with its ensuing economic problems associated with a reduction in public spending.

The increase in the marginal and average productivity of labour during the period 2002-2008 was not because of an increase in production, but because of a decline in the number of workers employed in the productive sector during that period.

- There was a clear decrease in the marginal and average productivity of capital input during the period 2002-2008, a period concurrent with an increase in oil prices, and the consequent increase in public spending. This use of huge amounts of capital units generated a low marginal and average productivity of capital.

- The average productivity of capital and labour were greater than the marginal productivity of the two factors. This was because the elasticity of production with respect to both factors was less than one, (0.57 for capital, and 0.13 for labour).

Table 7-4

Average and marginal productivity of production variables in the productive sector over the period 1970-2008

%

Year	*Elasticity value of capital (0.57)*		*Elasticity value of labour (0.13)*	
	MP_K	AP_K	MP_L	AP_L
1970	0.15	0.27	0.12	0.99
1971	0.12	0.22	0.10	0.7
1972	0.12	0.22	0.14	1.0
1973	0.12	0.21	0.19	1.5
1974	0.09	0.15	0.20	1.5
1975	0.08	0.14	0.23	1.8
1976	0.08	0.14	0.25	1.9
1977	0.07	0.12	0.24	1.8
1978	0.07	0.13	0.26	2.0
1979	0.07	0.13	0.24	1.9
1980	0.07	0.14	0.27	2.1
1981	0.07	0.132	0.29	2.2
1982	0.06	0.12	0.25	1.9
1983	0.07	0.12	0.25	1.9
1984	0.06	0.12	0.23	1.8
1985	0.07	0.13	0.25	1.9
1986	0.07	0.12	0.23	1.7
1987	0.07	0.12	0.22	1.6
1988	0.07	0.13	0.22	1.7
1989	0.07	0.13	0.22	1.6
1990	0.08	0.15	0.22	1.6
1991	0.09	0.16	0.21	1.6
1992	0.11	0.19	0.20	1.5
1993	0.12	0.22	0.19	1.5
1994	0.12	0.21	0.15	1.1
1995	0.13	0.24	0.13	1.0
1996	0.13	0.24	0.11	0.89
1997	0.15	0.26	0.10	0.83
1998	0.15	0.27	0.12	0.96
1999	0.16	0.29	0.11	0.87
2000	0.17	0.30	0.11	0.91
2001	0.15	0.27	0.21	1.6
2002	0.12	0.21	0.23	1.7
2003	0.10	0.19	0.23	1.8
2004	0.10	0.17	0.23	1.8
2005	0.09	0.16	0.23	1.8
2006	0.09	0.15	0.23	1.8
2007	0.08	0.15	0.31	2.4
2008	0.08	0.14	0.32	2.4

Figure 7-1: The average and marginal productivity of capital input in the Libyan productive sector during the period 1970-2008.

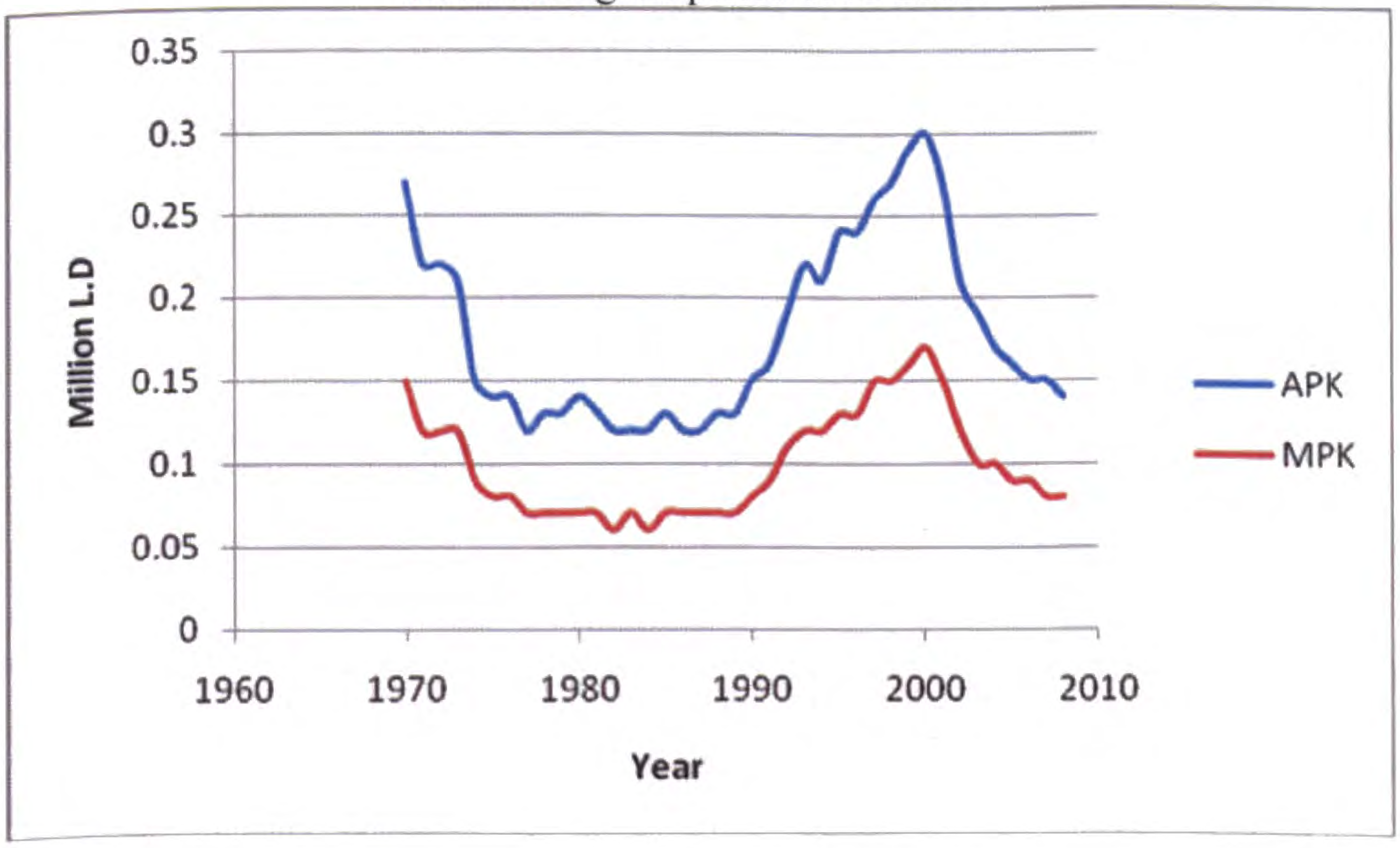
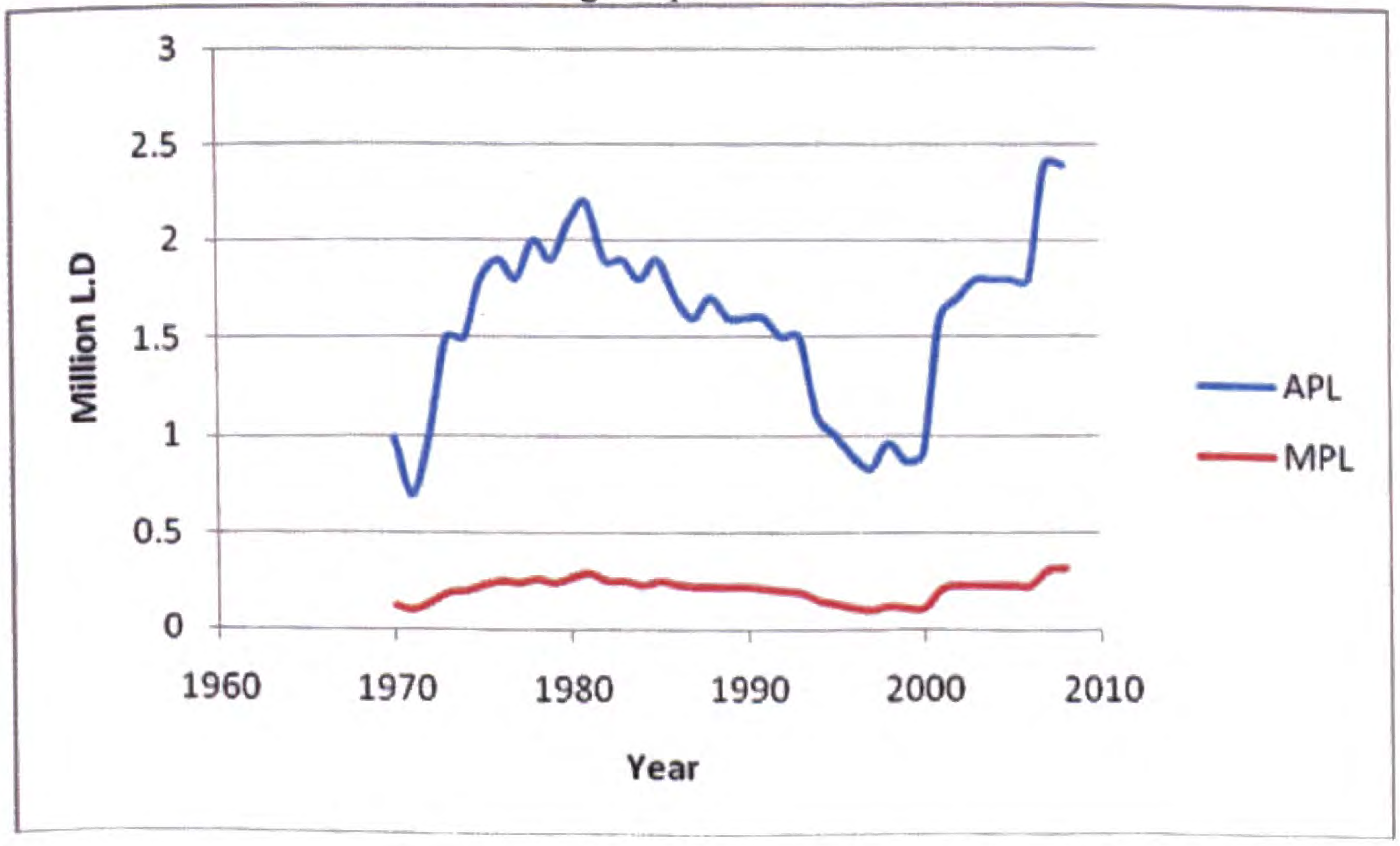


Figure 7-2: The average and marginal productivity of labour input in the Libyan productive sector during the period 1970-2008. .



7-5. *Model validation:*

In this study models have been built for the agriculture, manufacturing, and the total productive sector in the Libyan economy. Two kinds of equations (C-D and CES) have been estimated, in order to decide which one of them is more suitable for the Libyan economy, and to find the relative importance of factors which affect economic growth in these sectors. The estimation process is not the only step necessary to locate the target (evaluating the performance of the model, forecasting and policy analysis) in any econometric process, which should not rely solely on the behavioural quality of the estimated equations and their statistical significance: an equation may be effective and have good statistical significance, but may still not represent reality.

The second important step is to assess the ability of a model to represent reality, and evaluate its accuracy, and therefore to assess whether the model could be used to predict and also analyse different economic policies, in order to assist in developing appropriate economic policies for the Libyan economy.

To assess the accuracy of the model, a so-called historical simulation is used. The historical simulation is a mathematical solution for a set of simultaneous equations, where the estimated values can be obtained from the endogenous variables of the model using the actual values of exogenous variables and from the regression coefficients, which are obtained from the estimated equations.

7-6. *Tests used to evaluate the model:*

To evaluate the accuracy of the model and its ability to simulate and forecast, several statistical criteria are used, including a historical simulation, correlation coefficient (r), coefficient of determination (R^2) between estimated and actual values, Mean Absolute Error (M.A.E), Root Mean Square Error (R.M.S.E), and lastly the Thiel Inequality Coefficient. These criteria can be expressed in the following equations:-

1) Mean Absolute Error

$$M.A.E = \frac{1}{N}\sum_{t}^{N}(\hat{Y}_t - Y_t) \qquad (7\text{-}2)$$

2) Root Mean Square Error:-

$$R.M.S.E = \sqrt{\frac{1}{N}\sum_{t}^{N}}\ (\hat{Y}_t - Y_t)^2 \qquad (7\text{-}3)$$

The literature of the theories of statistics indicates that, when the values of $M.A.E$ and $R.M.S.E$ are close to zero, this means that the model is able to represent reality, so it can be used to predict the values of the future.

3) Theil Inequality Coefficient:

This criterion takes two forms which are as follow:

$$U_1 = \sqrt{\sum_{t}^{N}\frac{(\hat{Y}_t - Y_t)^2}{\sum Y_t^2}} \qquad (7\text{-}4)$$

$$U_2 = \sqrt{\sum_{t}^{N} \frac{(\hat{Y}_t - Y_t)^2}{\sum (Y_t - \bar{Y})}} \tag{7-5}$$

where:

$\hat{Y}_t$ = Estimated value of dependent variable (Y) during the t period.

Y = Actual value of dependent variable (Y) during the t period.

$\bar{Y}$ = Mean of dependent variable (Y).

N = Number of the observations.

According to these criteria, the model is accurate enough to enable forecasting and policy analysis when the value of U_1 and U_2 are close to zero. On the contrary, there is a reduced ability of the model to predict and analyse economic policies, when the values of U_1 and U_2 are close to one. Obado, Syaukat and Siregar (2009) stated that the Theil U coefficient should approach zero when the predicted series is close to the actual series.

Applying these criteria to the estimated equations 6-19, 6-21 and 7-1 for agriculture and manufacturing, and productive sector, in order to observe how closely the simulated values of the endogenous variables track their actual values, it is an examination of how close the actual series for the endogenous and exogenous variables are to the simulated values. The actual and simulated values of variables of the agriculture, manufacturing and productive sectors are shown in tables 7-8, 7-9 and 7-10 and by the figures 7-11 which is for the agriculture sector. Figure 7-12 is for the manufacturing sector and figure 7-13 for the total Libyan productive sector.

The figures and tables show that all the actual and simulated values of exogenous and endogenous variables are very close and the turning points of the actual series are well tracked by the simulated series. This confirms that the model is a good predictor of the historical behaviour of the exogenous and endogenous variables.

The model has also been evaluated by the above mentioned criteria for each sector. The results are tabled in 7-7, 7-8 and 7-9 for the agriculture, manufacturing and productive sectors respectively. The tables show that most of the results of the predictive tests are satisfactory; the results reflected the strong correlation between the actual and estimated series of each variable, this is clear from the values of r, R^2 ,$M.A.E$ and $R.M.S.E$. The results also show that the value of Thiel coefficient is located within the acceptable range $(1 > U > 0)$. The table shows that the Thiel coefficients for the sectors are very close to zero; this implies that the estimated model is suitable for policy simulation purposes. These results indicate that the model is effective, and can be used to predict the value of economic growth in the Libyan productive sector, and this is what planners and economic analysts need to develop appropriate economic policies, according to figures and statistics of previous years.

Table 7-5: Result of model validation to predict the value of the dependent variable in the Libyan agriculture sector during the study period.

R^2	$M.A.E$	$R.M.S.E$	U	r
0.92	-0.005	0.08	0.07	0.96

Table 7-6: Result of model validation to predict the value of the dependent variable in the Libyan Manufacturing sector during the study period.

R^2	$M.A.E$	$R.M.S.E$	U	r
0.97	-0.005	0.10	0.09	0.97

Table 7-7: Result of model validation to predict the value of the dependent variable in the Libyan Productive sector during the study period.

R^2	$M.A.E$	$R.M.S.E$	U	r
0.94	0.002	0.06	0.09	0.97

Table (7-8)
Actual and Simulated series of the exogenous variable in the Libyan agriculture sector during the period 1970-2008

year	Q	$\hat{Q}$	$\hat{Q}-Q$
1970	86.6	80.8	-5.7
1971	67.2	81.4	14.2
1972	94.2	93.5	-0.6
1973	135.7	113.7	-21.9
1974	138.2	138.8	0.6
1975	167.5	157.9	-9.5
1976	184.6	175.1	-9.4
1977	147.5	187.0	39.5
1978	178.2	198.5	20.3
1979	166.7	199.5	32.8
1980	236.4	207.3	-29.0
1981	264.1	227.6	-36.4
1982	246.5	231.4	-15.0
1983	236.5	234.3	-2.1
1984	224.1	235.4	11.3
1985	217.5	231.4	13.9
1986	236.7	233.8	-2.8
1987	242.5	234.5	-7.9
1988	242	237.8	-4.1
1989	248.3	244.1	-4.1
1990	251.0	243.0	-7.9
1991	252.3	233.9	-18.3
1992	254.9	224.9	-29.9
1993	239.0	225.7	-13.2
1994	218.1	214.5	-3.5
1995	196.7	205.3	8.6
1996	188.7	200.1	11.4
1997	185.4	197.1	11.7
1998	237.1	219.7	-17.3
1999	217.1	213.5	-3.5
2000	222.2	228.1	5.9
2001	235.5	217.3	-18.1
2002	253.1	252.0	-1.0
2003	263.6	270.3	6.7
2004	282.2	291.2	9.0
2005	298.9	315.2	16.3
2006	316.6	341.0	24.4
2007	332.5	311.3	-21.1
2008	313.3	299.2	-14.0

$\hat{Y}$ = Estimated value of Y

Table 7-9

Actual and Simulated series of the exogenous variable in the Libyan manufacturing sector during the period 1970-2008

year	Q	$\hat{Q}$	$\hat{Q}-Q$
1970	58.9	53.2	-5.7
1971	49.8	53.8	4.0
1972	69.1	67.1	-2.0
1973	99.0	88.4	-10.6
1974	117.5	113.1	-4.4
1975	132.3	132.4	0.1
1976	167.7	154.7	-13.0
1977	204.4	167.2	-37.2
1978	217.0	179.5	-37.5
1979	220.6	188.0	-32.6
1980	210.4	205.5	-4.9
1981	243.6	238.3	-5.3
1982	229.3	215.5	-13.8
1983	256.9	263.0	6.1
1984	250.6	243.4	-7.2
1985	268.0	236.6	-31.4
1986	221.2	231.9	10.7
1987	197.2	223.6	26.4
1988	227.1	223.8	-3.3
1989	232.8	222.1	-10.7
1990	237.8	210.6	-27.2
1991	221.4	190.6	-30.8
1992	224.5	214.2	-10.3
1993	235.8	191.8	-44
1994	159.1	167.1	8.0
1995	156.6	144.0	-12.6
1996	123.4	130.2	6.8
1997	119.7	119.5	-0.2
1998	132.5	127.7	-4.8
1999	129.2	114.7	-14.5
2000	150.1	158.2	8.1
2001	148.5	133.7	-14.8
2002	152.5	150.8	-1.7
2003	146.4	128.1	-18.3
2004	149.2	136.3	-12.9
2005	153.6	142.8	-10.8
2006	155.4	150.1	-5.3
2007	142.2	142.9	0.7
2008	127.5	138.0	10.5

$\hat{Y}$ = Estimated value of Y

Table 7-10

Actual and Simulated series of the exogenous variable in the Libyan productive sector during the period 1970-2008

year	Q	$\hat{Q}$	$\hat{Q}-Q$
1970	145.5	133.3	-12
1971	117.1	134.8	17
1972	163.3	163.3	0
1973	234.8	208.9	-25
1974	255.7	264.5	8
1975	299.8	307.0	7
1976	352.4	348.7	-3
1977	351.9	374.6	22
1978	395.3	397.4	2
1979	387.4	403.9	16
1980	446.8	429.9	-16
1981	507.7	487.7	-19
1982	475.8	500.1	24
1983	493.4	512.4	19
1984	474.7	514.0	39
1985	485.6	505.4	19
1986	458.0	508.5	50
1987	439.7	505.0	65
1988	469.1	507.8	38
1989	481.1	513.3	32
1990	488.8	497.4	8
1991	473.7	466.8	-6
1992	479.4	505.0	25
1993	475.0	478.8	3
1994	377.2	433.7	56
1995	353.3	395.5	42
1996	312.1	373.6	61
1997	305.2	352.9	47
1998	369.6	393.6	24
1999	346.3	370.3	24
2000	372.3	386.2	13
2001	384.0	390.5	6
2002	405.6	464.6	59
2003	410.0	435.9	25
2004	431.4	471.8	40
2005	452.5	510.2	57
2006	472.0	552.0	80.
2007	474.7	540.6	65
2008	440.8	537.3	96

$\hat{Y}$ = Estimated value of Y

Figure 7-3: Actual and simulated series of the exogenous variables in the Libyan agricultural sector during the period 1970-2008.

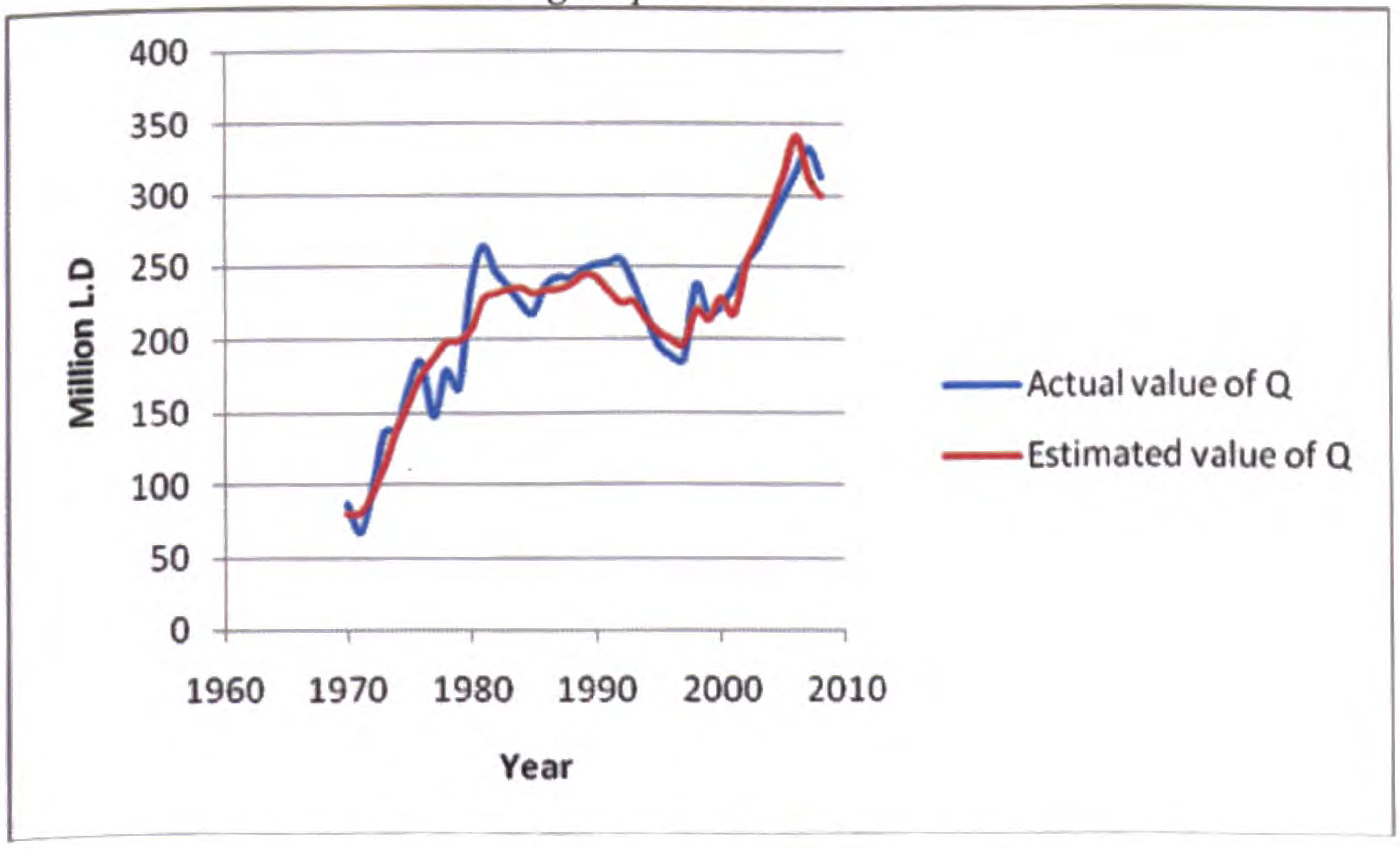


Figure 7-4: Actual and simulated series of exogenous variables in the Libyan manufacturing sector during the period 1970-2008.

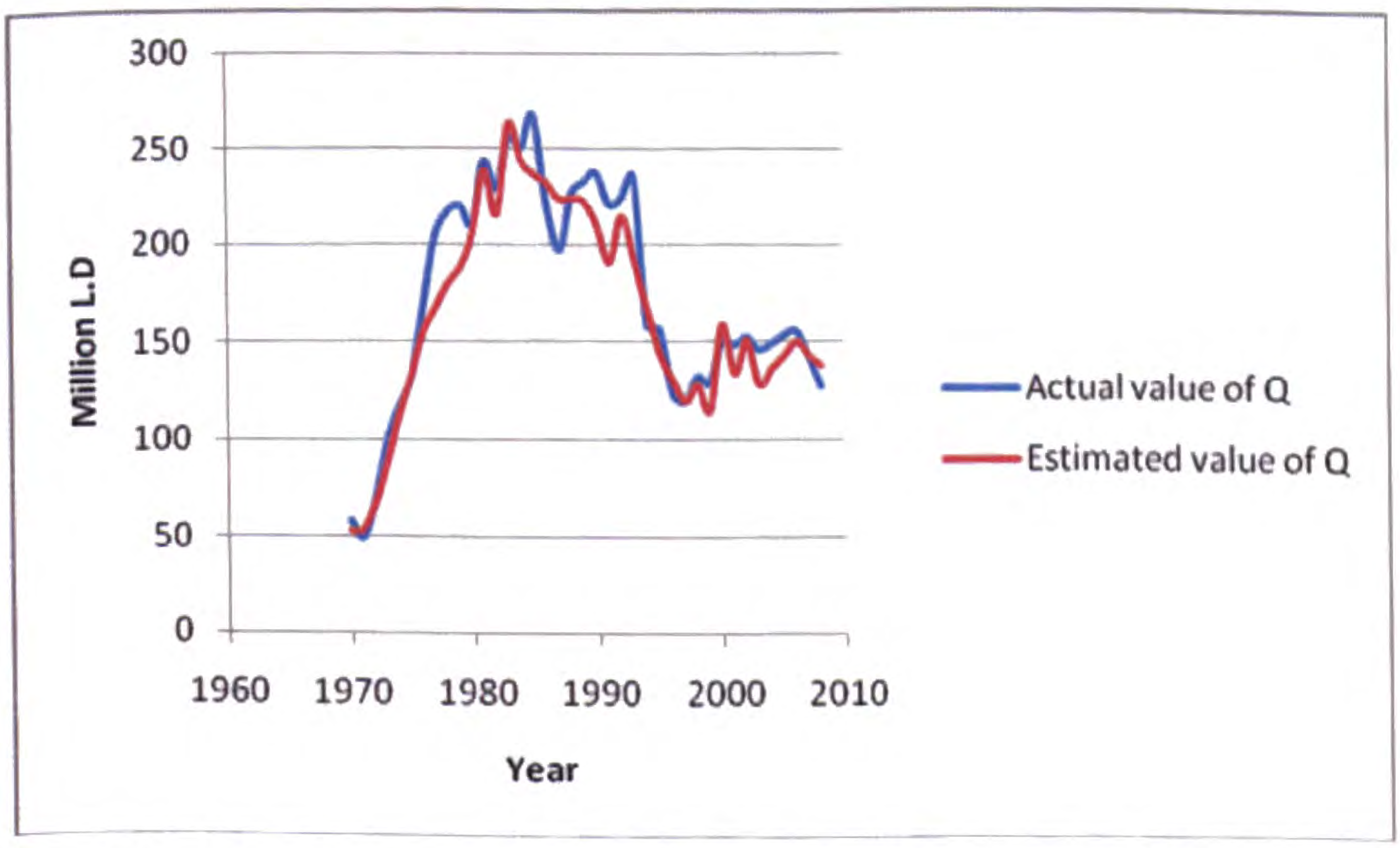


Figure 7-5: Actual and simulated series of the exogenous variables in the Libyan productive sectors during the period 1970-2008.

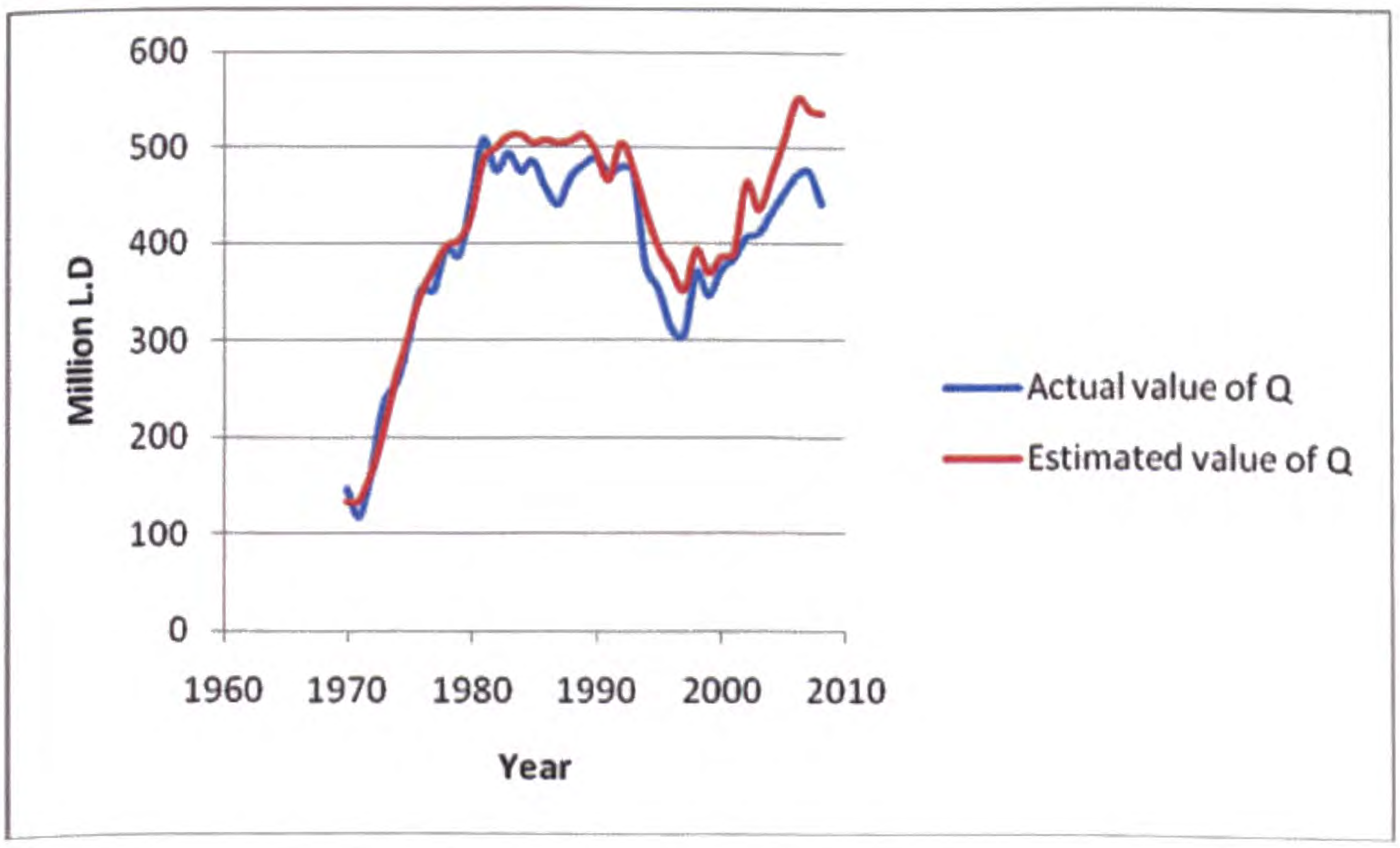


Table: 7-11

Simulated and actual value of endogenous and exogenous variables in the Libyan agricultural sector during the period 1970-2008

Year	$\ln Q$		$\ln K$		$\ln L$	
	estimated	*actual*	*estimated*	*actual*	*estimated*	*actual*
1970	4.39	4.46	5.92	5.77	5.21	4.83
1971	4.39	4.20	5.33	5.75	3.77	4.84
1972	4.53	4.54	6.03	6.01	4.88	4.84
1973	4.73	4.91	6.78	6.40	5.84	4.85
1974	4.93	4.92	6.78	6.79	4.85	4.87
1975	5.06	5.12	7.16	7.03	5.21	4.89
1976	5.16	5.21	7.31	7.20	5.24	4.95
1977	5.23	4.99	6.78	7.29	3.65	4.97
1978	5.29	5.18	7.15	7.38	4.39	4.99
1979	5.29	5.11	6.96	7.35	4.01	5.01
1980	5.33	5.46	7.68	7.39	5.76	5.03
1981	5.42	5.57	7.86	7.54	5.91	5.09
1982	5.44	5.50	7.66	7.53	5.46	5.12
1983	5.45	5.46	7.53	7.51	5.20	5.15
1984	5.46	5.41	7.35	7.45	4.94	5.22
1985	5.44	5.38	7.27	7.40	4.83	5.17
1986	5.45	5.46	7.41	7.39	5.25	5.18
1987	5.45	5.49	7.43	7.35	5.37	5.19
1988	5.47	5.48	7.37	7.33	5.32	5.23
1989	5.49	5.51	7.38	7.35	5.34	5.25
1990	5.49	5.52	7.38	7.31	5.41	5.24
1991	5.45	5.53	7.35	7.19	5.66	5.24
1992	5.41	5.54	7.33	7.06	5.97	5.27
1993	5.41	5.47	7.14	7.02	5.62	5.30
1994	5.36	5.38	6.90	6.86	5.41	5.32
1995	5.32	5.28	6.63	6.72	5.12	5.35
1996	5.29	5.24	6.49	6.62	5.06	5.39
1997	5.28	5.22	6.42	6.55	5.04	5.38
1998	5.39	5.46	6.91	6.74	5.83	5.41
1999	5.36	5.38	6.67	6.63	5.53	5.44
2000	5.42	5.40	6.67	6.73	5.33	5.47
2001	5.38	5.46	7.06	6.88	5.17	4.72
2002	5.52	5.53	7.20	7.19	4.69	4.67
2003	5.59	5.57	7.27	7.33	4.48	4.62
2004	5.67	5.64	7.36	7.43	4.51	4.69
2005	5.75	5.70	7.42	7.54	4.46	4.76
2006	5.83	5.75	7.48	7.65	4.42	4.83
2007	5.74	5.80	7.80	7.66	4.58	4.21
2008	5.70	5.74	7.75	7.65	4.18	3.93

Table: 7-12

Simulated and actual value of endogenous and exogenous variables in the Libyan manufacturing sector during the period 1970-2008

year	$\ln Q$		$\ln K$		$\ln L$	
	estimated	***actual***	***estimated***	***actual***	***estimated***	***actual***
1970	3.97	4.07	5.33	5.33	3.01	3.01
1971	3.98	3.90	5.36	5.36	3.06	3.06
1972	4.20	4.23	5.75	5.75	3.13	3.13
1973	4.48	4.59	6.18	6.18	3.25	3.25
1974	4.72	4.76	6.57	6.57	3.37	3.37
1975	4.88	4.88	6.80	6.80	3.49	3.49
1976	5.04	5.12	7.01	7.01	3.62	3.62
1977	5.11	5.32	7.11	7.11	3.72	3.72
1978	5.19	5.38	7.18	7.18	3.85	3.85
1979	5.23	5.39	7.22	7.22	3.96	3.96
1980	5.32	5.34	7.34	7.34	4.06	4.06
1981	5.47	5.49	7.57	7.57	4.15	4.15
1982	5.37	5.43	7.61	7.61	4.30	4.30
1983	5.57	5.54	7.65	7.65	4.38	4.38
1984	5.49	5.52	7.67	7.67	4.27	4.27
1985	5.46	5.59	7.63	7.63	4.31	4.31
1986	5.44	5.39	7.63	7.63	4.34	4.34
1987	5.41	5.28	7.59	7.59	4.36	4.36
1988	5.41	5.42	7.58	7.58	4.45	4.45
1989	5.40	5.45	7.55	7.55	4.52	4.52
1990	5.35	5.47	7.44	7.44	4.59	4.59
1991	5.25	5.40	7.30	7.30	4.61	4.61
1992	5.36	5.41	7.14	7.14	4.65	4.65
1993	5.25	5.46	6.93	6.93	4.72	4.72
1994	5.11	5.06	6.68	6.68	4.79	4.79
1995	4.96	5.05	6.44	6.44	4.82	4.82
1996	4.86	4.81	6.28	6.28	4.85	4.85
1997	4.78	4.78	6.06	6.06	4.99	4.99
1998	4.85	4.88	6.18	6.18	5.05	5.05
1999	4.74	4.86	6.00	6.00	5.09	5.09
2000	5.06	5.01	5.95	5.95	5.13	5.13
2001	4.89	5.00	6.05	6.05	4.75	4.75
2002	5.01	5.02	6.29	6.29	4.77	4.77
2003	4.85	4.98	6.43	6.43	4.80	4.80
2004	4.91	5.00	6.56	6.56	4.83	4.83
2005	4.96	5.03	6.66	6.66	4.87	4.87
2006	5.01	5.04	6.77	6.77	4.91	4.91
2007	4.96	4.95	6.79	6.79	4.85	4.85
2008	4.92	4.84	6.79	6.79	4.84	4.84

Table: 7-13

Simulated and actual value of endogenous and exogenous variables in the Libyan productive sector during the period 1970-2008

year	$\ln Q$		$\ln K$		$\ln L$	
	estimated	***actual***	***estimated***	***actual***	***estimated***	***actual***
1970	4.89	4.98	6.27	6.27	4.98	4.98
1971	4.90	4.76	6.27	6.27	4.99	4.99
1972	5.09	5.09	6.58	6.58	5.01	5.01
1973	5.34	5.45	6.99	6.99	5.04	5.04
1974	5.57	5.54	7.38	7.38	5.07	5.07
1975	5.72	5.70	7.61	7.61	5.11	5.11
1976	5.85	5.86	7.80	7.80	5.18	5.18
1977	5.92	5.86	7.90	7.90	5.22	5.22
1978	5.98	5.97	7.98	7.98	5.27	5.27
1979	6.00	5.95	7.98	7.98	5.31	5.31
1980	6.06	6.10	8.06	8.06	5.35	5.35
1981	6.18	6.22	8.25	8.25	5.42	5.42
1982	6.21	6.16	8.26	8.26	5.48	5.48
1983	6.23	6.20	8.28	8.28	5.53	5.53
1984	6.24	6.16	8.26	8.26	5.55	5.55
1985	6.22	6.18	8.22	8.22	5.52	5.52
1986	6.23	6.12	8.21	8.21	5.54	5.54
1987	6.22	6.08	8.17	8.17	5.55	5.55
1988	6.23	6.15	8.16	8.16	5.60	5.60
1989	6.24	6.17	8.15	8.15	5.64	5.64
1990	6.20	6.19	8.07	8.07	5.66	5.66
1991	6.14	6.16	7.94	7.94	5.67	5.67
1992	6.22	6.17	7.79	7.79	5.70	5.70
1993	6.17	6.16	7.67	7.67	5.74	5.74
1994	6.07	5.93	7.47	7.47	5.78	5.78
1995	5.98	5.86	7.28	7.28	5.82	5.82
1996	5.92	5.74	7.16	7.16	5.85	5.85
1997	5.86	5.72	7.03	7.03	5.90	5.90
1998	5.97	5.91	7.19	7.19	5.94	5.94
1999	5.91	5.84	7.06	7.06	5.98	5.98
2000	5.95	5.91	7.11	7.11	6.01	6.01
2001	5.96	5.95	7.24	7.24	5.43	5.43
2002	6.14	6.00	7.53	7.53	5.42	5.42
2003	6.07	6.01	7.67	7.67	5.41	5.41
2004	6.15	6.06	7.78	7.78	5.46	5.46
2005	6.23	6.11	7.89	7.89	5.51	5.51
2006	6.31	6.15	7.99	7.99	5.56	5.56
2007	6.29	6.16	8.01	8.01	5.28	5.28
2008	6.28	6.08	8.00	8.00	5.18	5.18

Figure 7-6: Actual and simulated series of the exogenous variable (ln Q) in the Libyan agriculture sector during the period 1970-2008.

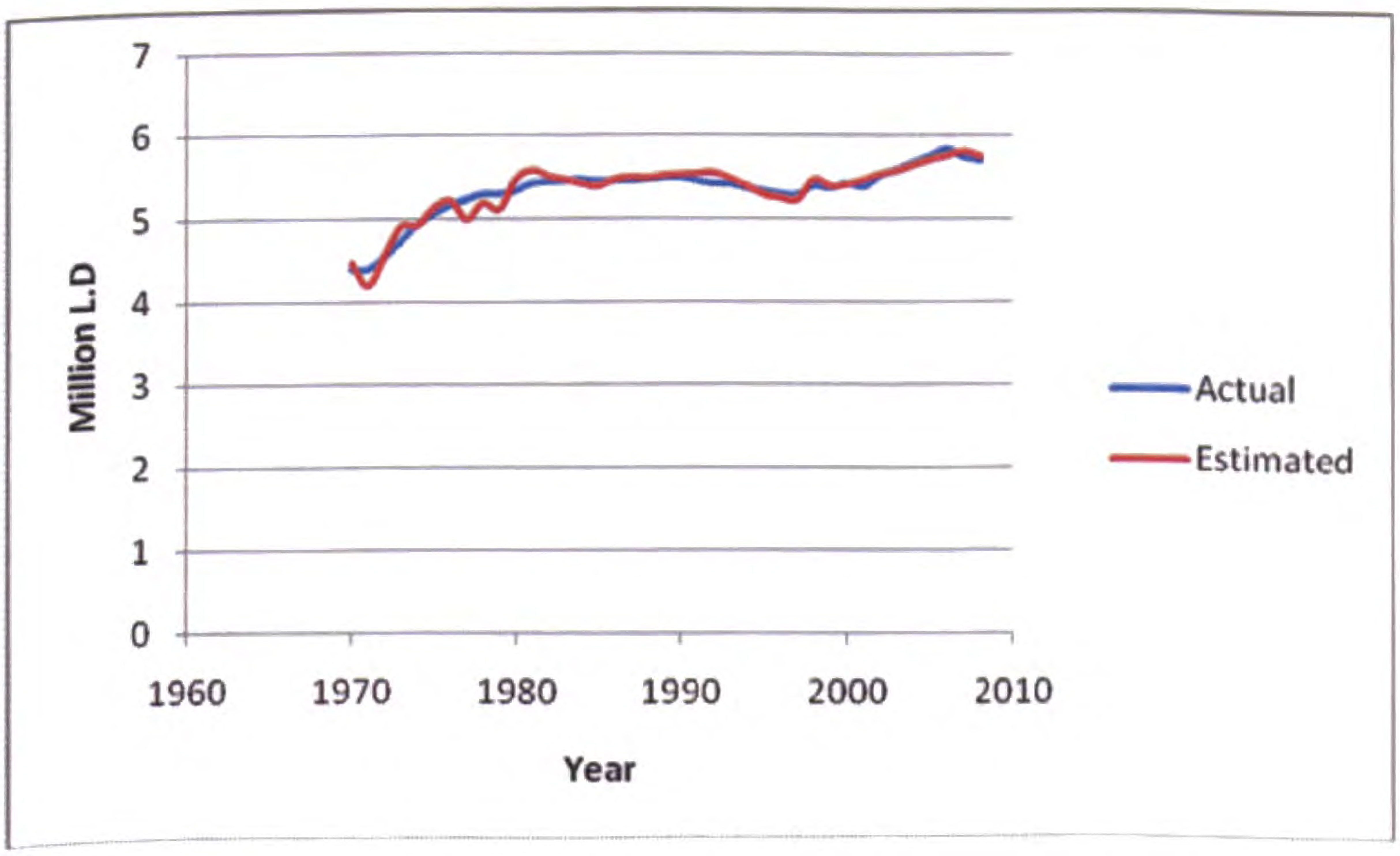


Figure 7-7: Actual and simulated series of the endogenous variable (lnK) in the Libyan agriculture sector during the period 1970-2008.

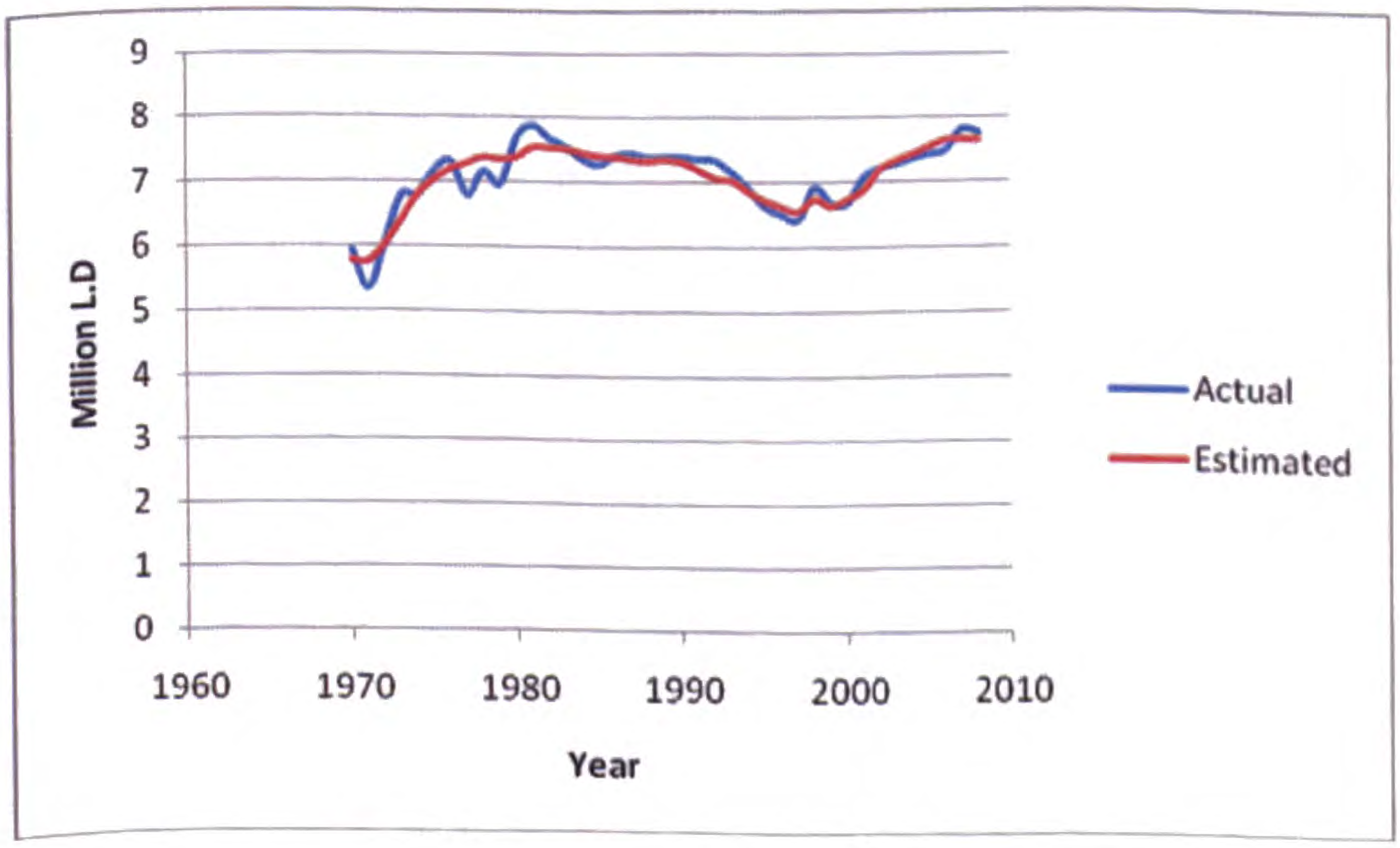


Figure 7-8: Actual and simulated series of the exogenous variable (lnL) in the Libyan agriculture sector during the period 1970-2008.

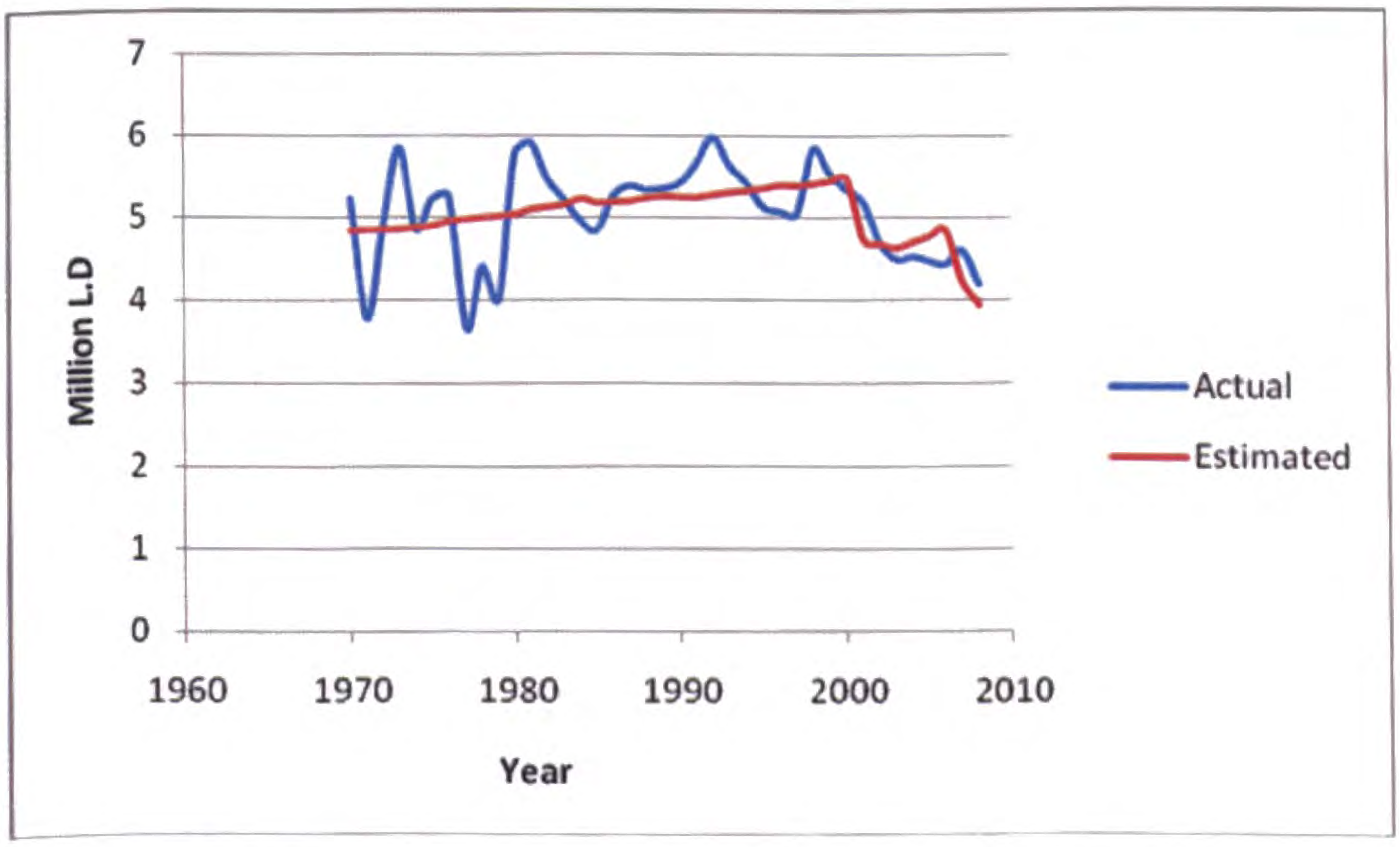


Figure 7-9: Actual and simulated series of the exogenous variable (lnQ) in the Libyan manufacturing sector during the period 1970-2008.

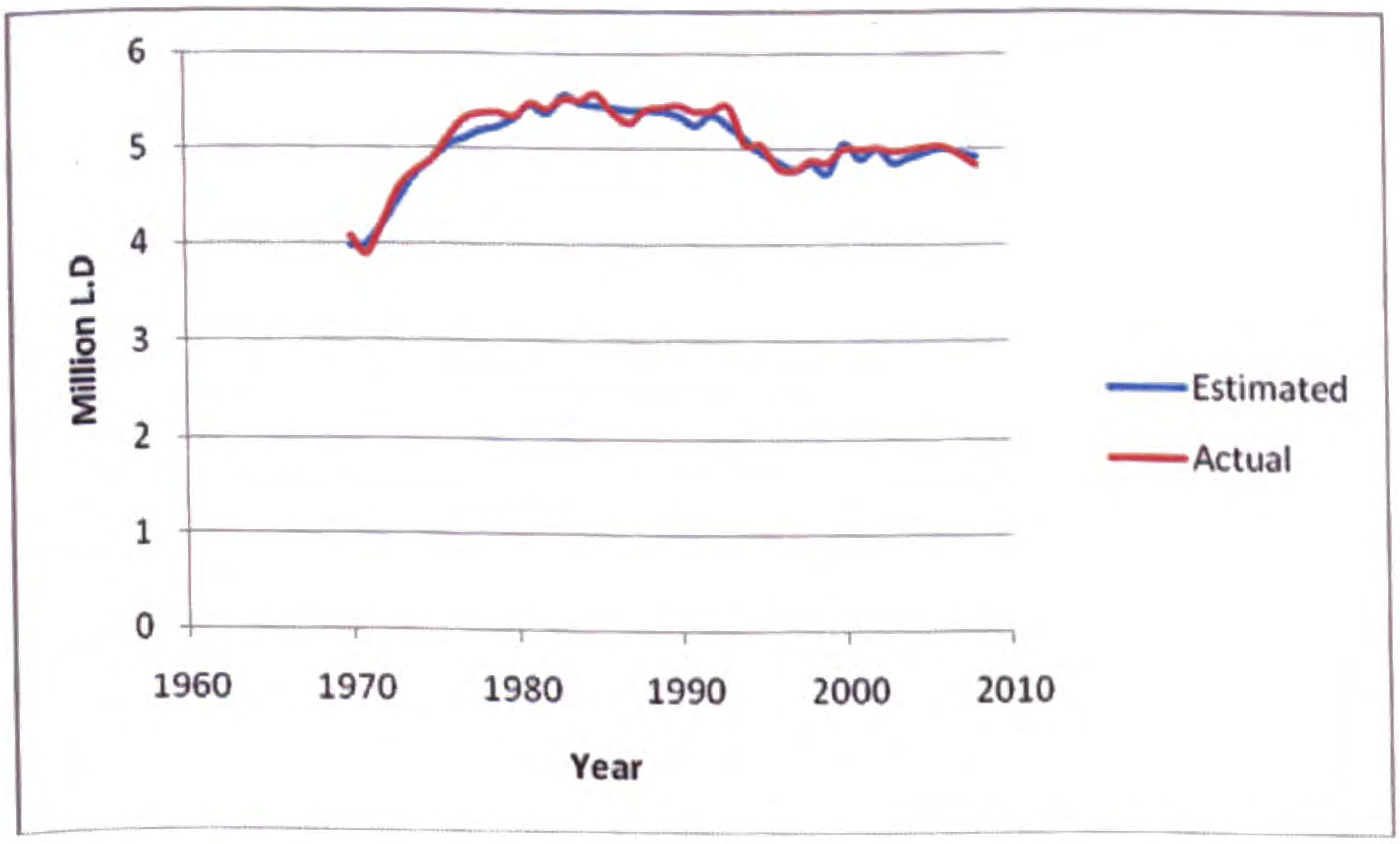


Figure 7-10: Actual and simulated series of the endogenous variable (lnK) in the Libyan manufacturing sector during the period 1970-2008.

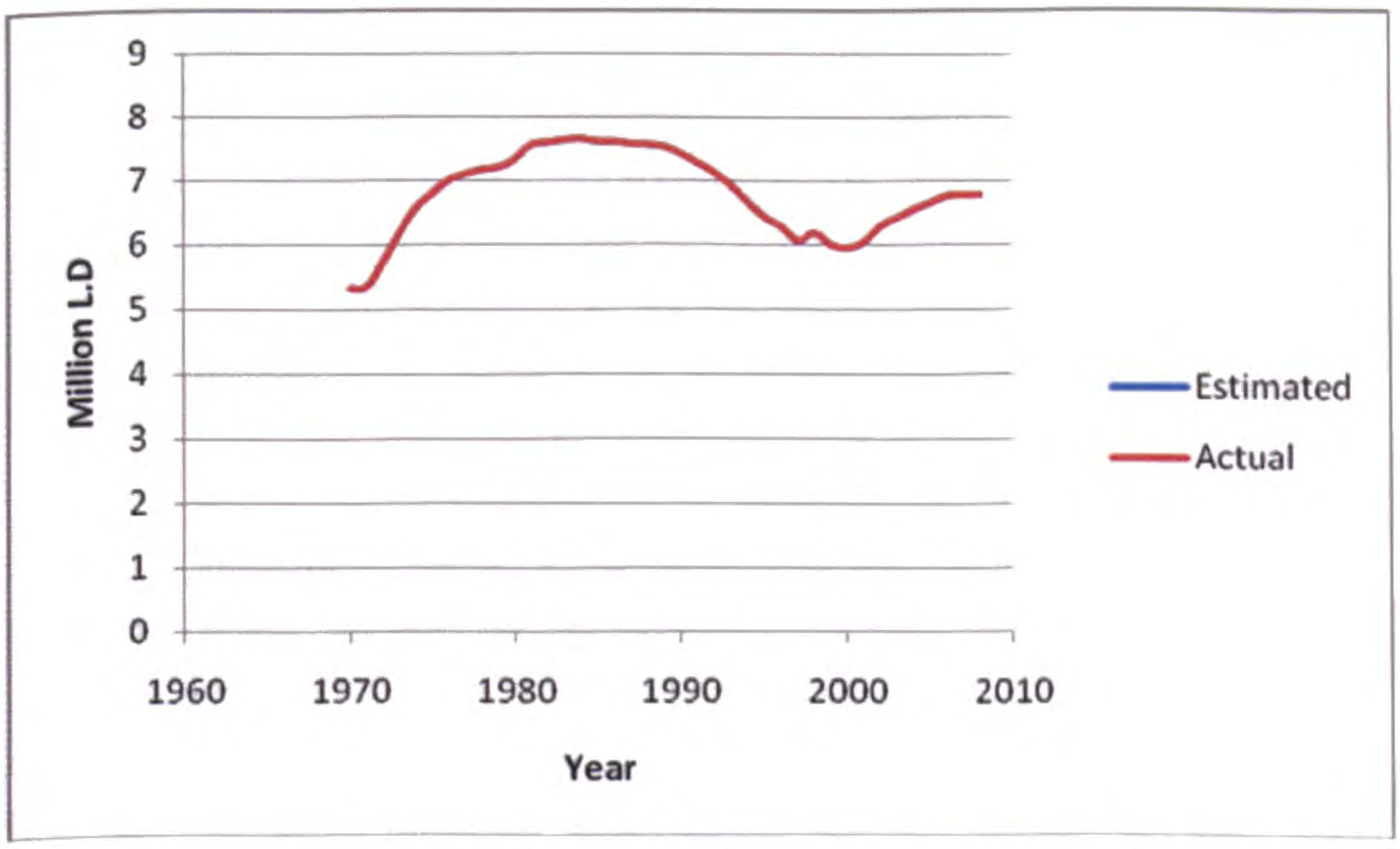


Figure 7-11: Actual and simulated series of the endogenous variable (lnL) in the Libyan manufacturing sector during the period 1970-2008.

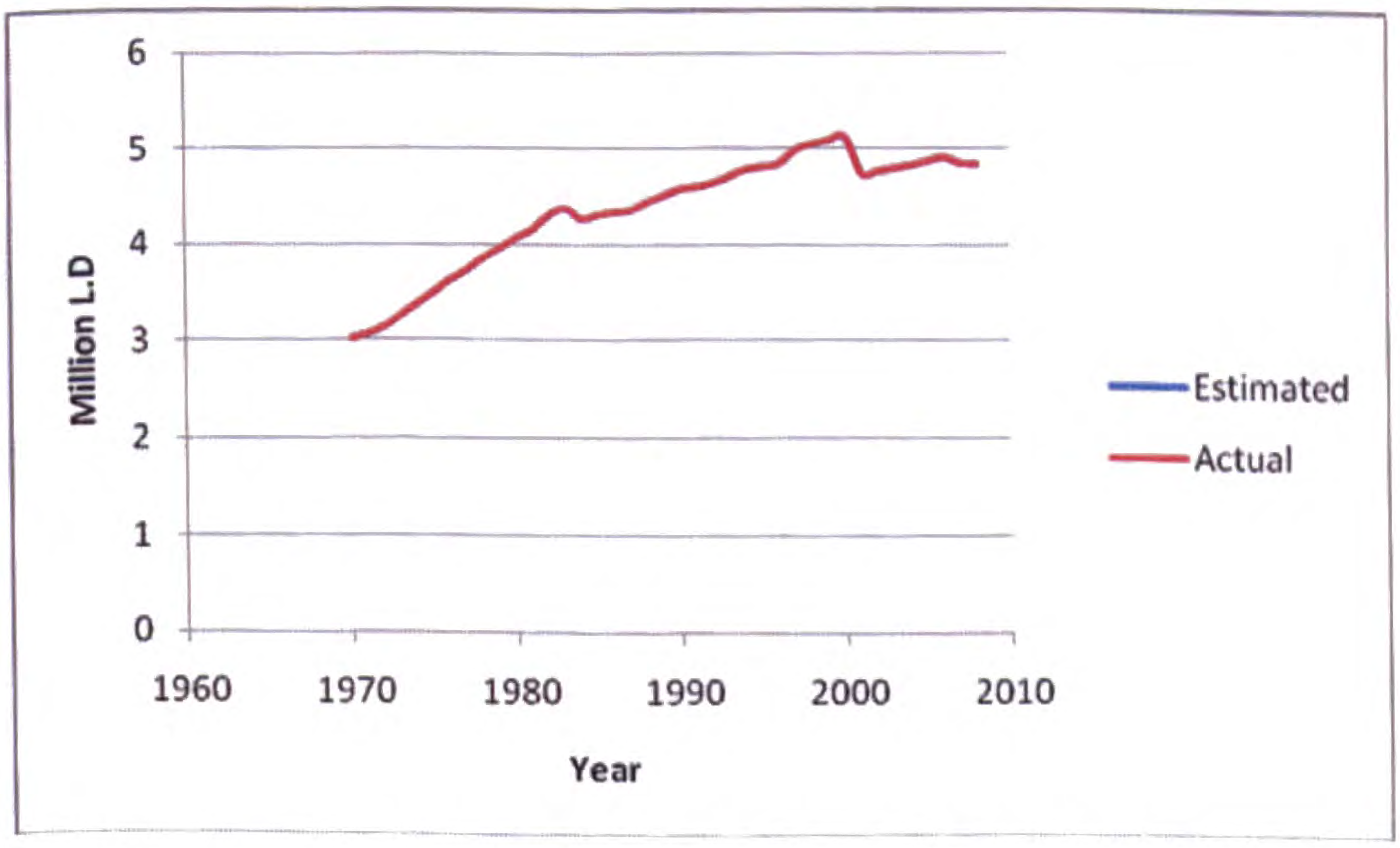


Figure 7-12: Actual and simulated series of the exogenous variable (lnQ) in the Libyan productive sector during the period 1970-2008.

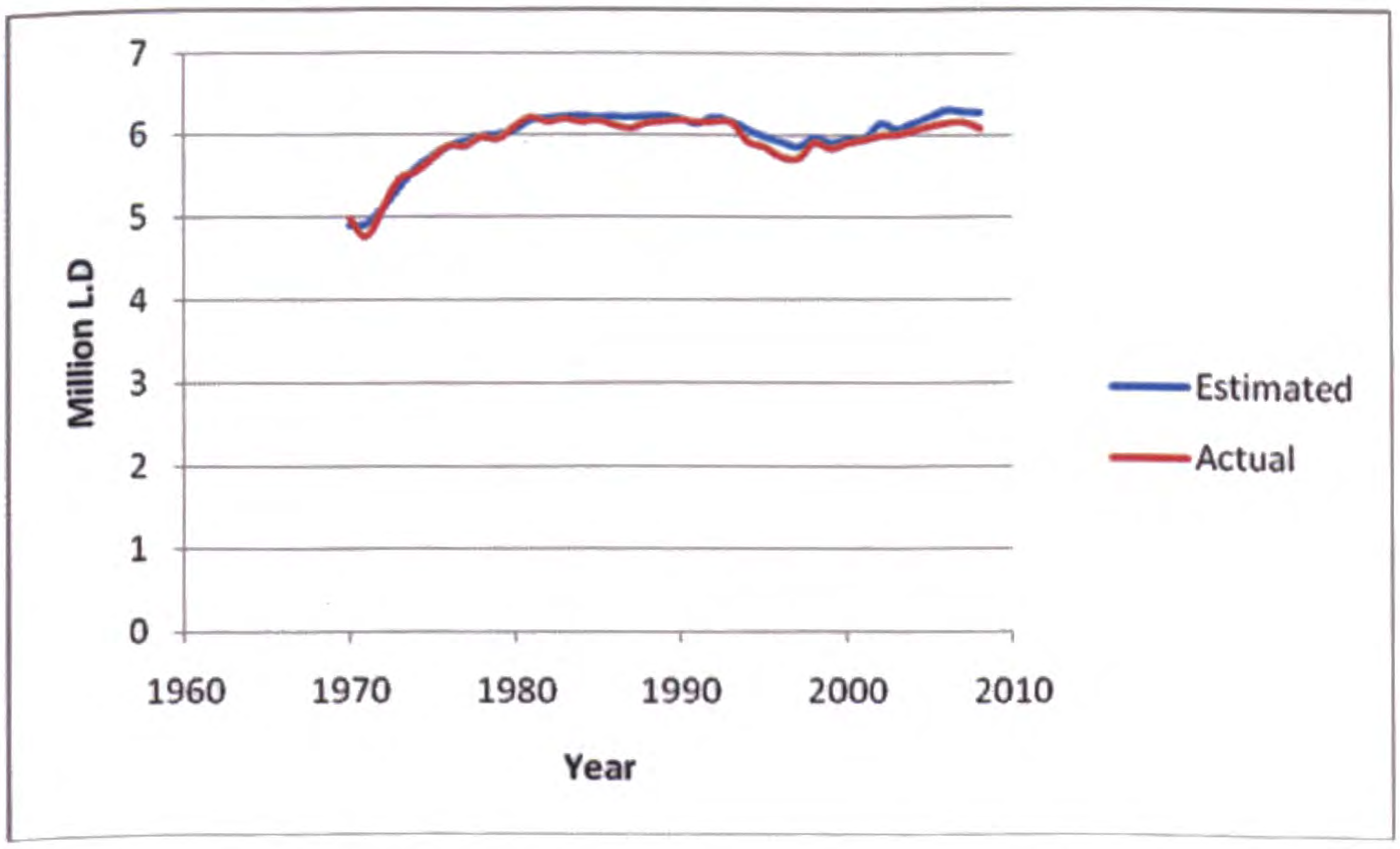


Figure 7-13: Actual and simulated series of the endogenous variable (lnK) in the Libyan productive sector during the period 1970-2008.

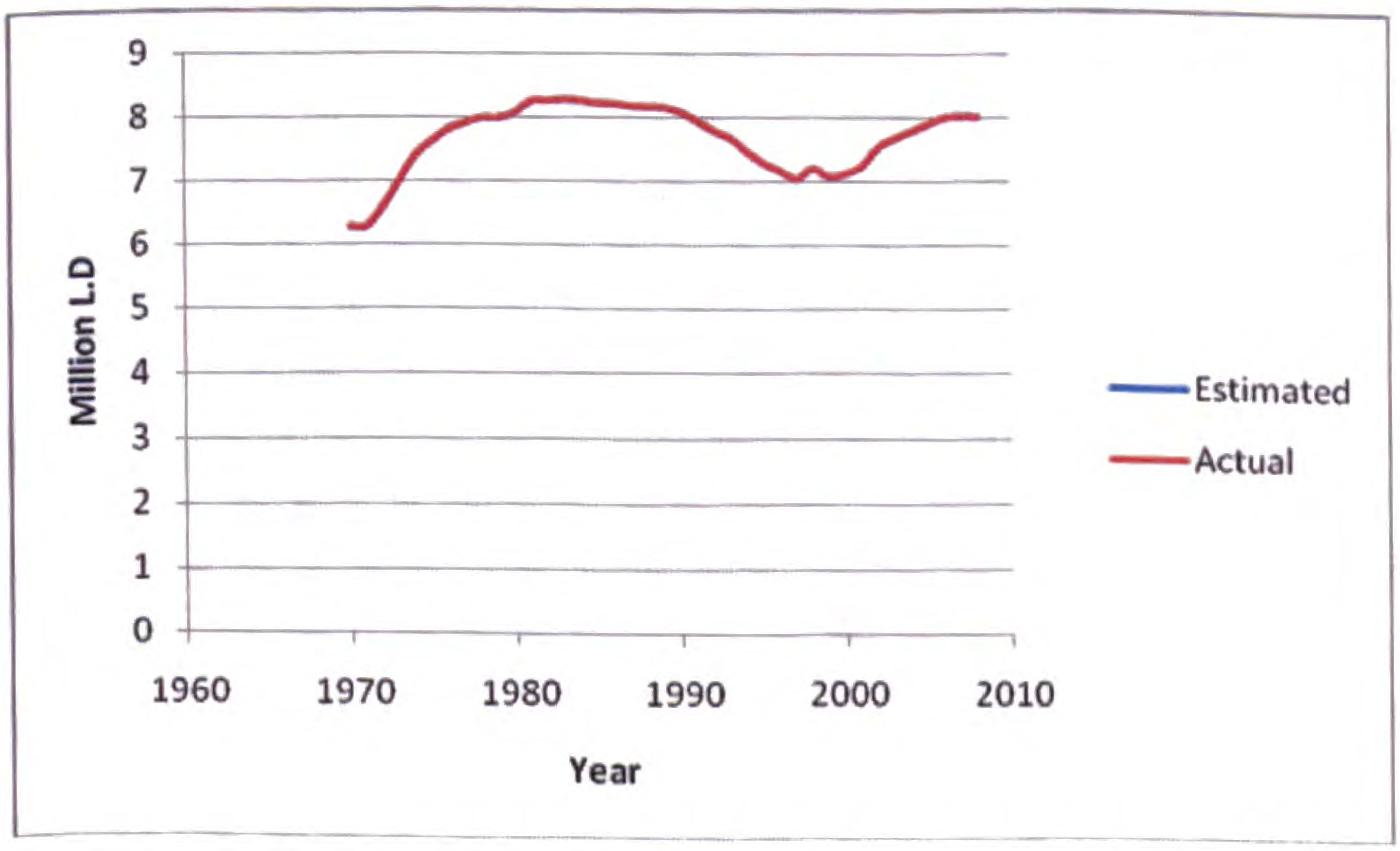
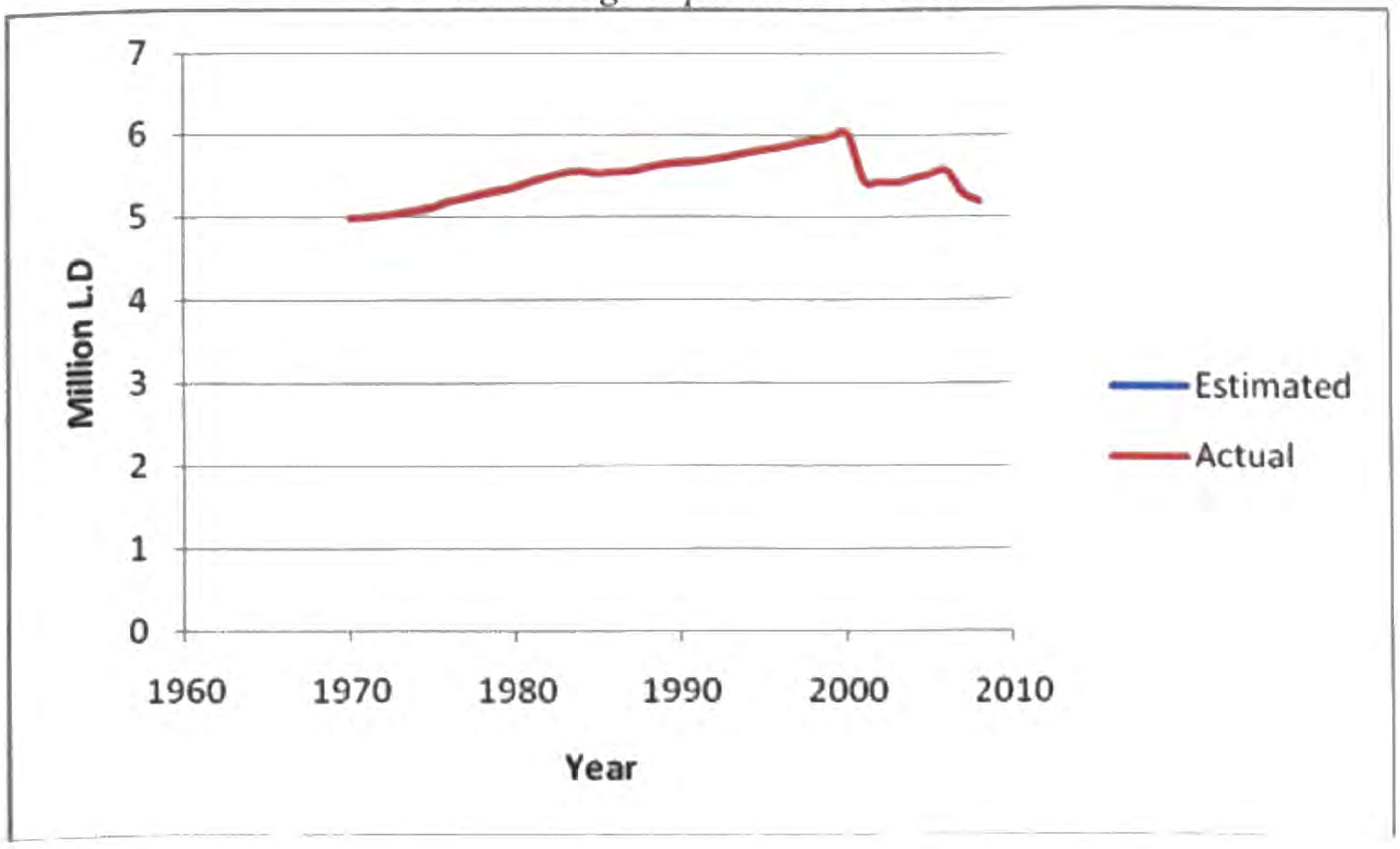


Figure 7-14: Actual and simulated series of the endogenous variable (lnL) in the Libyan productive sector during the period 1970-2008.



7-7 Conclusion:

The C-D and CES production functions were estimated in this chapter in their various forms for the Libyan productive sector. The data used in the estimation process is defined by variables collected in both the Libyan agriculture and manufacturing sectors, forming one sector which is designated the productive sector. The contribution to GDP of the productive sector is the contribution of the manufacturing sector plus that of the agricultural sector. This was also the case with respect to labour and capital inputs, the number of workers in this sector is expressed as the sum of the total number of workers in the agricultural and manufacturing sectors, also the capital input is the net of total capital stock in both sectors. The C-D and CES forms have been estimated differently from the previous chapter, because some studies, such as Salem (2004), have found that the form of the function may depend on the type of sector it investigates. The two functions are estimated with restriction and non-restriction of Constant Returns to Scale (CRS) and with both specifications of constant and variant Hicks neutral technical progress. The estimation results using the Ordinary Least Square (OLS) method show:

- The estimation result of CES parameters show that the ρ value does differ from zero indicating that there is no unity of the elasticity of substitution exist between capital and labour inputs. Statistical criteria indicate that the Cobb-Douglas production function is the best fit for the Libyan productive sector.
- Labour, capital and technical progress are significant explanatory variables in the productive sector. GDP in this sector has been positively affected by disembodied technical progress, but its effect was very small.
- Production in the Libyan productive sector exhibits decreased returns to scale, the sum of the two estimated coefficients of labour and capital is more than one ($\varepsilon = 0.70$).
- GDP elasticity with respect to capital is higher than GDP elasticity with respect to labour, reflecting greater responsiveness of GDP to changes in capital stock than to labour.
- Finely, the performance of the production model of the three sectors (agriculture, manufacturing and productive sectors) was tested by several statistical criteria (Historical simulation, $M.A.E$, $R.M.S.E$, Theil inequality coefficient and correlation coefficient, and coefficient of determination between estimated and actual values). The simulated values of the exogenous variable (contribution to GDP of the agriculture, manufacturing and productive sectors) are listed with actual values for the period 1970-2008. The quantitative measures of how closely individual variables track their corresponding actual data series are also listed. An examination of simulated data series in comparison with their corresponding actual data series shows that the simulated data series closely track their corresponding historical data series.

CHAPTER EIGHT

Summary and Conclusion

8-1. Summary

Since the discovery of oil in 1961, the Libyan economy has increasingly benefited from this natural resource, at the same time it has also brought problems for economic development because the heavy dependence of oil has resulted in very volatile revenue for Libya in the light of international market economic forces. Therefore, the Libyan government has tried to place more emphasis on other areas of economic activity to diversify away from its dependency on oil as the major source of economic growth. The country has since 1970 exerted notable efforts aimed at achieving economic diversification. The main objective of the Libyan economic development plans since 1970 has been to improve the performance and efficiency of the non oil sectors, especially the agriculture and manufacturing sectors and a result of a large amount of investment has been poured into these sectors. However, directing large amounts of investment to these sectors has not lead to an improvement in their performance.

To implement a diversification strategy, the Libyan government has directed a large proportion of investment to its agriculture and manufacturing sectors in order to find other sources of income apart from oil (Abdulhamid, 2005). The agriculture and manufacturing sectors received 15.4% and 12% respectively of total investment on average during the period 1970-2008 (LSP, 2007).

Theoretically, making large investments should lead to improvement in the performance of the sectors (Ming, and Xia, 2007). This has not been the case in Libya. The agriculture and manufacturing sectors contribution to GDP was 4.80 % and 4.40 % respectively on average during the same period 197-2008. Therefore, this study set out to determine the more suitable specification of production functions (C-D or CES) for the Libyan economy, in order to investigate the relative importance of factor inputs and technical progress in contributing the GDP growth in the agriculture and manufacturing sectors over the period 1970-2008.

The main purpose of this study can be summarized in two aspects:

- Firstly, it estimates the two most commonly used production functions, which are Cobb-Douglas and Constant Elasticity of Substitution, in order to determine the best fit function for the Libyan economy.

- Secondly, it investigates the contribution made by factor inputs and by technical progress to growth in GDP of the Libyan productive sectors. Determining the preferable function can be carried out through calculating the elasticity of substitution between capital and labour, which can be obtained through testing the value of the substitution parameter (ρ).

The literature suggested that if the estimated value of substitution parameter (ρ) is found to be significant, and if the elasticity of substitution (σ) was not equal to one the CES production function would be a better choice, while if the value of ρ was not significant and the elasticity of substitution between two factor inputs (capital and labour) was equal to one, the C-D production function would be preferred than CES (Sadeg, 1996 and Sahin (2003).

Some other statistical criteria are also used, in order to choose between the specification of constant and variant Hicks neutral technical progress and of constant and variable returns to scale in 5-13 and 5-14, their determination coefficients (R^2) value were compared. The $F-test$ and $T-test$ were also used, in order to discriminate the preferred specification. The $T-test$ was applied to test significance of the parameter estimates. The $F-test$ is used to test the overall significance of a regression. This test aims to find out whether the explanatory variables (dependents variables) do actually have any significant influence on the independent variable.

The approach used to investigate economic growth in the Libyan productive sector was growth accounting analysis, which lies at the heart of neo-classical growth theory. According to the growth accounting analysis, the growth in GDP is explained by a model characterised by the rate of growth of the production factors (such as capital and labour) parameters that determine the elasticity of GDP with respect to each factor of production, and residual which contributes to the GDP growth that is not accounted for by changes in factor inputs. In this research the growth rate of GDP was used as an indicator of economic development and real GDP is used instead of nominal GDP, in order to exclude any defects produced due to inflationary factors. Capital input is expressed by capital stock, an accumulation of the past capital formation. According to the literature, there are a number of methods which can be used to express labour input. However, the total number of workers was chosen in this study because of the availability of data. The choice of the period under study is mainly dictated by the availability of data. The year 1980 has been chosen as the base year in the series of the GDP 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 source of the data was the publications of the General People's Committee of Planning and the Central Bank of Libya.

A number of approaches can be used to measure the contribution made by technical progress. Constant and variant Hicks neutral technical change methods were chosen in this study. The Ordinary Least Square (OLS) method was used in the estimation process, because the parameters obtained by OLS have some optimal properties, such as best, linearity and unbiased. The computational procedure of OLS is also fairly simple as compared with other econometric techniques, and the data requirements are not excessive.

Most economic time series in general are not stationary and at best become stationary only after differencing. The non-stationarity of economic variables is usually related to econometric problems such as spurious regression. In this study the DF and ADF tests were used, in order to test the stationarity of variables used in the estimation process. The results of DF and ADF indicated acceptance of the null hypothesis of unit roots using the absolute value (level) of variables of the agricultural, manufacturing and productive sectors. However, the null hypothesis was rejected in the case when using the first difference of value of variables, confirming the possibility of using the first difference of the observation of the variables.

The co-integration test of Johansen (1988) was used to investigate whether any stable long-run relationships exist between dependent and independent variables. The results indicate the possibility of using the level of variables integrated at the same rank in the regression for all specifications, as in the case of the Libyan agricultural, manufacturing and productive sectors.

Both Cobb-Douglas and Constant Elasticity of Substitution were estimated in their different forms of Constant and Variable Returns to Scale, and using the two forms of constant and variant Hicks neutral technical change. The two functions were estimated for the Libyan agriculture and manufacturing sectors separately and combined.

The empirical results obtained in this study can be summarised as follows:

Firstly, the principal finding of the analysis of the Libyan agriculture and manufacturing sectors is that the best form of production function among the different forms used in this study to describe the production process in these sectors is a Cobb-Douglas production function with constant Hicks neutral technical change, and under the assumption of Variable Returns to Scale (VRS).

Secondly, with regard to regression results, the elasticity of GDP with respect to capital and labour estimated were 46% and 18% respectively in the agriculture sector (Table 6-7) and 56% and 50% respectively in the manufacturing sector (Table 6-11). The contribution of technical change to growth of GDP was 1.6% in the agriculture and 3% in the manufacturing sector.

Thirdly, from the above figures, it can be noted that the elasticity of GDP with respect to capital is higher than the elasticity of GDP with respect to labour in both sectors (agriculture and manufacturing) indicating that the growth rate in the Libyan agriculture and manufacturing sectors are more responsive to capital input than labour input.

Fourthly, the Libyan agricultural sector is characterized by decreased returns to scale, because the sum of the two estimated parameters of capital and labour is less than one. However, production in the Libyan manufacturing sector exhibits constant returns to scale, because the sum of the two estimated parameters of capital and labour is equal to one.

Fifthly, technical change that accrued during the period 1970-2008 was growing at constant rates in the Libyan agriculture and manufacturing sectors, and it positively affected the GDP in these sectors, but its effect was relatively small, as indicated by a low elasticity of GDP with respect to technical progress in both sectors.

Finally, the economic embargo on Libya during the period 1992-2002 had a positive impact on the manufacturing sector ($D_1 = 22\%$) and had no impact on the agricultural sector. The manufacturing sector was affected negatively in the time of the world recession in the year of 1982 ($D_3 = -16\%$) and positively in the period 2002-2008 ($D_4 = 36\%$), the latter coincided with major structural and management change in the country, a surge in oil prices and an increase in the quota of oil exports, resulting in huge increases in GDP.

Based upon the above findings, it can be argued that: all the economic sectors in Libya were more responsive to capital input than labour. Technical progress had a positive effect on the agriculture and manufacturing sectors, but its effect was relatively small, this maybe because the Libyan productive sectors are public owned which did not adopt new technology.

The labour input also had a positive impact on the growth of GDP in both agriculture and manufacturing sectors, but its impact was less than capital input. This was because most of the local workers used in these sectors were unskilled.

Despite directing a large amount of investment into the productive sectors, these investments did not achieve the projected returns. The ineffectiveness of government investment expenditure on the productivity of the Libyan productive sectors can be assigned to a number of factors.

First, the Libyan productive sector is overwhelmingly publicly owned. Second, using the investments ineffectively is perhaps another factor attributing to the inefficiency of Libyan investment in productive sectors, which may be attributed to mismanagement in Libya. Finally, the low elasticity of substitution between production factors (capital and labour) led to difficulty of replacing capital with labour. All these factors mentioned above may lead to increased production costs, resulting in the ineffectiveness of investments.

8-2. Policy implications:

Some policy implications can be derived based on the empirical results which can help the policy makers to reallocate available resources in a more effective way. It is clear from the results that the growth rate in the Libyan productive sectors is more sensitive to changes in capital input than labour, as indicated by the higher elasticity of GDP with respect to capital than labour. Since the elasticity of substitution between production factors (capital and labour) influences the effectiveness of capital, including economic growth in Libya, policy makers should take into account the relationship between the elasticity of substitution and the effectiveness of investment spending on productive sectors by maintaining an optimal level of the labour-capital ratio, in order to maximize production. In addition, policy makers should improve to the quality of labour through providing more opportunity for education and training.

In addition to improvement of the quality of labour, a high growth rate in the Libyan economy, especially in the productive sectors, may also be achieved by increasing the import of capital goods, because imported capital goods tend to embody advancement in technology that can be beneficial to production.

Furthermore, it could be suggested that the Libyan productive sectors should be converted from public to private ownership as a lot of studies have shown that public owned enterprises are less efficient than their private counterparts.

It is vital for the government to encourage foreign investment, particularly in agriculture and industry sectors because of its great economic benefit to the country. The expansion of investment in profitable industrial activities, which rely heavily on local raw materials, is also required.

8-3. Suggestion for further research:

Several suggestions should be mentioned for further research relating to this study.

1- The first suggestion is related to the measuring of factor inputs. This study used labour input relying on the number of workers as a quantitative variable, because the lack of data on working hours and of wages in the Libyan database. Other studies have used alternative ways to measure production factors, for example, the number of hours worked instead of the number of workers was used in some studies. In future studies alternative measurement may be used. This work could also be extended to include other factors in the production function along with capital and labour, such as amount of land cultivated, fertilizer, raw materials and agricultural loans.

   Moreover, the level of human capital and investment on research and development (R&D) could also be included. Of course, these are conditional on data availability.

2- This study applied two kinds of production function (Cobb-Douglas and Constant Elasticity of Substitution production functions) within Libyan context, further work may be carried out using different sets of production functions, such as Variable Elasticity of Substitution, Leontief, and Trans-long production functions.

3- This study has concerned the factors affecting economic growth, such as technical progress, further work might be carried out using different way to measure the effect of this factor rather than time trend (direct approach).

4- Finally, as this study is concerned with the effect of production factors on economic growth in the long-run, only dynamic model equations were used in this study. When quarterly or half year unit observation data become available the Error Correction Model (ECM) should be used to estimate the short-run effect.

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Appendices

Appendix (A): Data set of the model

Table A(1)

The contribution of agriculture in GDP during the period 1970-2008

The value in million L.D at current prices

year	Agricultural GDP	GDP volume	Agricultural to GDP %	Annual growth rate
1970	33.1	1288.3	2.6	-
1971	33	1586.5	2.1	-0.3
1972	43.6	1753.0	2.5	32.1
1973	60	2182.5	2.7	37.6
1974	64.7	3795.7	1.7	7.8
1975	82.9	3674.3	2.3	28.1
1976	99.7	4768.1	2.1	20.3
1977	90	5612.7	1.6	-9.7
1978	122.1	5496.1	2.2	35.7
1979	140.4	7603.0	1.9	15
1980	236.4	10553.8	2.2	68.4
1981	273.6	8798.8	3.1	15.7
1982	285.7	8932.4	3.2	4.4
1983	303	5811.7	3.6	6.1
1984	323	7804.7	4.1	6.6
1985	342.2	7852.1	4.4	5.9
1986	384.7	6760.7	5.5	12.4
1987	411.2	6011.6	6.8	6.9
1988	423.3	6186	6.8	2.9
1989	439.8	7191	6.1	3.9
1990	482.9	8246.8	5.9	9.7
1991	542.4	8757.3	6.2	12.3
1992	630.2	9231.9	6.8	16.2
1993	708.8	9137.7	7.8	12.5
1994	827.9	9670.8	8.6	16.8
1995	933.4	10672.3	8.7	12.7
1996	1074.5	12327.3	8.7	15.1
1997	1267	13800.5	9.2	17.9
1998	1394.3	12610.6	11	10
1999	1449.9	14075.2	10.4	4
2000	1437.7	17620.2	8.2	-0.8
2001	1319.8	18079.1	7.3	-8.2
2002	1294.6	25914.1	5.0	-1.9
2003	1332.9	37360.7	3.6	2.9
2004	1328.6	48105.4	2.8	-0.3
2005	1447.5	66450.7	2.2	8.9
2006	1643.0	80729.9	2.0	13.5
2007	1905.3	89260.3	2.1	15.9
2008	2020.7	105728.4	1.9	6.1

Sources: General Authority for Information and Documentation; Council of General Planning (the Ministry of Planning), Central Bank of Libya, IMF, World Bank; Privatization and Investment Board.

Table A(2)

Manufacturing GDP and its share in the GDP during the period 1970-2008

The value in million LD at current prices.

year	*Manufacturing GDP*	*GDP volume*	*Manufacturing of GDP %*	*Growth rate*
1970	22.5	1288.3	1.7	-
1971	24.5	1586.5	1.5	8.9
1972	32	1753.0	1.8	30.6
1973	43.8	2182.5	2	36.9
1974	55	3795.7	1.5	25.6
1975	65.5	3674.3	1.8	19.1
1976	90.6	4768.1	1.9	38.3
1977	124.7	5612.7	2.2	37.6
1978	148.7	5496.1	2.7	19.2
1979	185.8	7603.0	2.4	24.9
1980	210.4	10553.8	2	13.2
1981	252.4	8798.8	2.9	20
1982	265.8	8932.4	3	5.3
1983	329.1	5811.7	3.9	23.8
1984	361.2	7804.7	4.6	9.8
1985	421.7	7852.1	5.4	16.6
1986	359.6	6760.7	5.2	-14.7
1987	334.5	6011.6	5.6	-7
1988	397.2	6186	6.4	18.7
1989	412.3	7191	5.7	3.8
1990	457.6	8246.8	5.6	11
1991	476.1	8757.3	5.4	4
1992	555	9231.9	6	16.6
1993	699.6	9137.7	7.7	26.1
1994	604	9670.8	6.3	-13.7
1995	743.1	10672.3	7	23
1996	702.9	12327.3	5.7	-5.6
1997	818.6	13800.5	5.9	16.5
1998	779.3	12610.6	6.2	-4.8
1999	863.1	14075.2	6.1	10.8
2000	972.9	17620.2	5.5	12.7
2001	877.8	18079.1	4.8	-9.7
2002	813.1	25914.1	3.1	-7.3
2003	764.7	37360.7	2.0	-5.9
2004	761.1	48105.4	1.58	-0.4
2005	799	66450.7	1.20	4.9
2006	806.9	80729.9	0.99	0.98
2007	814.9	89260.3	0.91	0.99
2008	823	105728.4	0.77	0.99

Sources: General Authority for Information and Documentation; Council of General Planning (the Ministry of Planning), Central Bank of Libya, IMF, World Bank; Privatization and Investment Board.

Table A(3)

Labour force in agriculture and industry sectors, and its percentage to total labour in Libya during the period 1970-2008.

The numbers in thousand.

years	*Agricultural sector*				*Industrial sector*				*Total labour*
	Number of labour	*% to total labour*	*increase rate of labour %*	*Per capita income*	*Number of labour*	*% to total labour*	*Increase rate of labour %*	*Per capita income*	
1970	126	29.1	-	0.2	20.4	4.7	-	1.1	433.5
1971	127	27.7	0.8	0.2	21.4	4.6	4.9	1.1	459
1972	127.7	26.2	0.6	0.3	22.9	4.7	7	1.3	488
1973	129	24	1	0.4	25.9	4.8	13.1	1.6	538.1
1974	131.4	21.6	1.9	0.4	29.3	4.8	13.1	1.8	607.2
1975	133.4	19.7	1.5	0.6	32.9	4.8	12.3	1.9	677.4
1976	141.2	19.3	5.8	0.7	37.4	5.1	13.7	2.4	732.7
1977	144.9	19	2.6	0.6	41.5	5.5	11	3.0	764.8
1978	147.9	19.1	2.1	0.8	47.4	6.1	14.2	3.1	772.7
1979	150.1	19	1.5	0.9	52.8	6.7	11.4	3.5	789
1980	153.4	18.9	2.2	1.5	58	7.1	9.8	3.6	812.8
1981	162.4	17.2	5.9	1.6	64	6.8	10.3	3.9	946.6
1982	167.5	15.5	3.1	1.7	73.7	6.8	15.2	3.6	1083.7
1983	173	14.7	3.3	1.7	80.5	6.8	9.2	4.0	1179.5
1984	185.5	20	7.2	1.7	72	7.8	-10.6	5.0	927.1
1985	177	19.8	-4.6	1.9	75	8.4	4.2	5.6	894.2
1986	178.5	19.7	0.8	2.1	77	8.5	2.7	4.6	904.7
1987	180	19.2	0.6	2.2	79	8.4	2.6	4.2	936.8
1988	186.9	19.4	3.8	2.2	85.8	8.9	8.6	4.6	963.1
1989	191.6	19.1	2.5	2.2	92.2	9.3	7.5	4.4	995.4
1990	188.9	18.5	-1.4	2.5	99.4	9.8	7.8	4.6	1018.6
1991	189.6	18.7	0.4	2.8	101.1	10	1.7	4.7	1012.5
1992	195.7	18.7	3.7	3.2	105.4	10.1	4.3	5.2	1044
1993	201.2	18.1	2.8	3.5	112.6	10.1	6.8	6.2	1113.6
1994	206	18.2	2.4	4.0	120.5	10.5	7	5.0	1149
1995	212.7	17.8	3.3	4.3	124.5	10.5	3.3	5.9	1186.2
1996	219.5	17.8	3.2	4.8	128.5	10.5	3.2	5.4	1224
1997	219.2	17.5	-0.1	5.7	147.8	11.8	15	5.5	1255.1
1998	225.1	17	2.7	6.1	156.8	11.8	6.1	4.9	1323.7
1999	232	16.7	3.1	6.2	163.7	11.8	4.4	5.2	1383.8
2000	239.1	16.5	3.0	6.0	169.6	11.7	3.6	5.7	1445
2001	113.2	7.8	-52.0	11.6	115.8	8.0	-31.7	9.7	1448.4
2002	107.2	7.2	-5.30	12.	118.7	7.9	2.5	12.4	1492.6
2003	102.1	6.6	-4.7	13.0	121.6	7.9	2.4	16.3	1535.0
2004	109.2	6.9	6.9	12.1	126.2	7.9	3.8	19.4	1588.8
2005	117.0	7.0	7.1	12.3	131.2	7.9	3.9	23.8	1665.2
2006	125.8	7.3	7.5	13.0	136.3	7.9	3.9	26.4	1727.2
2007	67.9	3.9	-46.0	28.0	128.5	7.3	-5.7	31.3	1749.7
2008	51.00	2.8	-24.9	39.6	127.2	7.1	-1.0	37.3	1797.4

Sources: General Authority for Information and Documentation; Council of General Planning (the Ministry of Planning), Central Bank of Libya, IMF, World Bank; Privatization and Investment Board.

Notes: per capita income in the two sectors was calculated from tables (1), (2) and table (3), and their value in million L.D.

Table A(4)

Oil GDP, its share in GDP and its labour force

The value of oil GDP in million LDs with current price.
The number of labour in thousand. *At current prices*

years	Oil GDP	Oil to GDP %	Oil growth rate	Labour in oil sector	% to total labour	Increase rate of labour	Per capita income
1970	812.6	63.1	-	10	2.3	-	81.26
1971	922.7	58.2	13.5	10	2.2	-	92.27
1972	920.6	52.5	-0.2	10	2.1	-	92.06
1973	1131.8	51.9	22.9	10.2	1.9	2	110.9
1974	2385.3	62.9	110.8	10.4	1.7	2	229.3
1975	1961.1	53.4	-17.8	10.7	1.6	2.9	183.2
1976	2750	57.7	40.2	11	1.5	2.8	250.0
1977	3275.9	58.4	19.1	11.3	1.5	2.7	289.9
1978	2808.7	51.1	-14.3	11.7	1.5	3.5	240.0
1979	4545.3	59.8	61.8	11.7	1.5	-	388.4
1980	6525.7	61.8	43.6	13.7	1.7	17.1	476.3
1981	4403.3	50	-32.5	13.8	1.5	0.7	319.0
1982	4235.8	47.4	-3.8	14	1.3	1.4	302.5
1983	3823.6	44.9	-9.7	13.8	1.2	-1.4	277.0
1984	3209.8	41.1	-16.1	13	1.4	-5.8	246.9
1985	3500.4	44.6	-9.1	13.5	1.5	3.8	259.2
1986	2595.8	37.3	-25.8	13.6	1.5	0.7	190.8
1987	1857.4	31.2	-27.8	13.7	1.5	-2.1	135.5
1988	1570	25.4	-16.3	15.4	1.6	12.4	101.9
1989	2055.5	28.6	30.9	15.7	1.6	1.9	130.9
1990	3243.8	39.3	57.8	16.9	1.7	7.6	191.9
1991	3104.3	35.4	-4.3	17.5	1.7	3.6	177.3
1992	2925.7	31.7	-5.8	18.1	1.7	3.4	161.6
1993	2460.1	26.9	-15.9	18.5	1.6	2.2	132.9
1994	2892.9	29.9	17.6	19.2	1.7	3.8	150.6
1995	3380	31.7	16.8	19.8	1.7	3.1	170.7
1996	3960.3	32.1	17.2	20.5	1.7	3.5	193.1
1997	4505.8	32.6	13.8	21.6	1.7	5.4	208.6
1998	2786	22.1	-38.2	37.5	2.8	73.6	74.2
1999	3995.9	28.4	43.4	38.7	2.8	3.2	103.2
2000	6661	37.8	66.7	39.9	2.8	3.1	166.9
2001	6784.2	37.5	1.8	40.0	2.8	0.25	169.6
2002	13630.6	52.6	100.9	43.9	2.9	9.7	310.4
2003	21514.4	57.5	57.8	45.7	2.9	4.1	470.7
2004	30848.4	64.1	43.4	48.9	3.1	7.0	630.8
2005	46205.7	69.5	49.8	50.4	3.0	3.1	916.7
2006	58358.1	72.3	26.3	53.4	3.1	5.9	1092.8
2007	61834.2	69.3	5.9	58.5	3.3	9.5	1056.9
2008	74121.9	70.1	19.8	61.6	3.4	5.3	1203.2

Sources: General Authority for Information and Documentation; Council of General Planning (the Ministry of Planning), Central Bank of Libya, IMF, World Bank; Privatization and Investment Board.

Table.A (5)
Oil GDP, its share in GDP and its labour force

The value of oil GDP in million LD at constant price of 1980.
The number of labour in thousand

years	*Oil GDP*	*Oil to GDP %*	*Oil growth rate*	*Labour in oil sector*	*% to total labour*	*Increase rate of labour*	*Per capita income*
1970	2127.2	63.1	-	10	2.3	-	212.7
1971	1879.2	58.2	-11	10	2.2	-	187.9
1972	1988.3	52.5	6	10	2.1	-	198.8
1973	2560.6	51.9	29	10.2	1.9	2	251.0
1974	5096.8	62.9	99	10.4	1.7	2	490.0
1975	3961.8	53.4	-22	10.7	1.6	2.9	370.2
1976	5092.6	57.7	28	11	1.5	2.8	462.9
1977	5370.3	58.4	5	11.3	1.5	2.7	475.2
1978	4100.3	51.1	-23	11.7	1.5	3.5	350.4
1979	5398.2	59.8	31	11.7	1.5	-	461.3
1980	6525.7	61.8	21	13.7	1.7	17.1	476.3
1981	4250.3	50	-35	13.8	1.5	0.7	307.9
1982	3654.7	47.4	-14	14	1.3	1.4	261.0
1983	2984.8	44.9	-18	13.8	1.2	-1.4	216.2
1984	2227.5	41.1	-25	13	1.4	-5.8	171.3
1985	2225.3	44.6	-0.09	13.5	1.5	3.8	164.8
1986	1597.4	37.3	-28	13.6	1.5	0.7	117.4
1987	1105.8	31.2	-31	13.7	1.5	-2.1	80.7
1988	897.6	25.4	-18	15.4	1.6	12.4	58.2
1989	1160.6	28.6	29	15.7	1.6	1.9	73.9
1990	1686.0	39.3	45	16.9	1.7	7.6	99.7
1991	1443.8	35.4	-14	17.5	1.7	3.6	82.5
1992	1183.5	31.7	-18	18.1	1.7	3.4	65.3
1993	829.4	26.9	-30	18.5	1.6	2.2	44.8
1994	762.1	29.9	-8	19.2	1.7	3.8	39.6
1995	712.3	31.7	-6	19.8	1.7	3.1	35.9
1996	695.4	32.1	-2	20.5	1.7	3.5	33.9
1997	659.3	32.6	-5	21.6	1.7	5.4	30.5
1998	473.8	22.1	-28	37.5	2.8	73.6	12.6
1999	598.2	28.4	26	38.7	2.8	3.2	15.4
2000	1027.9	37.8	71	39.9	2.8	3.1	25.7
2001	1147.9	37.5	0.2	40.0	2.8	0.25	28.6
2002	2557.3	52.5	122	43.9	2.9	9.7	58.2
2003	3628.4	60	42	45.7	2.9	4.1	79.39
2004	5338.8	65	47	48.9	3.1	7.0	109.1
2005	7528.9	70	41	50.4	3.0	3.1	149.3
2006	11244.3	72	49	53.4	3.1	5.9	210.5
2007	10791.3	69	-4	58.5	3.3	9.5	184.4
2008	11491.8	70	6.5	61.6	3.4	5.3	186.5
period		***Average of annual growth rate***					
1970-1985		***4.7%***					
1986-2007		***12.5%***					

Source: was calculated by research from table (4) and table (8) in appendix.

Table A(6)

Agriculture and Manufacturing expenditure compared with total investment expenditure during the period 1970-2000.

The value in million L.D and at current prices

year	Agriculture expenditure	% of total expenditure	Industry expenditure	% of total expenditure	Oil expenditure	% of total expenditure	Total expenditure	% of total expenditure
1970	23.4	16	15	10.3	1.5	1	146	100
1971	47.8	19.2	29	11.7	15.3	6.2	247.6	100
1972	63.8	16.1	65.1	16.4	27.8	7	397.4	100
1973	88.9	21.5	62.5	15.1	28.5	6.9	413.8	100
1974	223.9	25.9	107	12.5	56.8	6.6	866	100
1975	242.2	26.2	100	10.8	52.9	5.7	923.2	100
1976	288.1	24.3	165.5	13.9	67.3	5.7	1187.2	100
1977	263.7	20.6	160.7	12.6	67.7	5.2	1280.3	100
1978	281.8	20.5	157.1	11.6	80	5.8	1371.3	100
1979	379.7	20.3	210.2	11.2	93.4	5	1868.8	100
1980	489.9	19.2	583.2	22.9	55.3	2.2	2551.6	100
1981	487.5	17	530.7	18.5	57.6	2	2872.6	100
1982	308.6	13.1	409.7	17.3	25.2	1.1	2365.9	100
1983	252.9	12.1	455.7	21.7	19	0.9	2096.3	100
1984	262.3	14.3	381.5	20.8	18.6	1	1834.7	100
1985	182.8	12	289.2	19	129.1	8.5	1523.3	100
1986	120.4	10.8	201.3	18	1.2	0.1	1117.1	100
1987	105.6	13.4	158.7	20.1	7.5	1	788.4	100
1988	100	13.8	112.8	15.6	17.7	2.4	722.4	100
1989	145.1	17.6	95.9	11.6	24.3	3	823.4	100
1990	217.8	31	35.8	5.1	16	2.3	702	100
1991	236.2	32.7	9.4	1.3	37	5.1	723.3	100
1992	29.2	7.4	20.2	5.1	32.6	8.2	396.3	100
1993	194.9	48.1	11.6	2.9	49.9	12.3	405.2	100
1994	14	2.8	35.5	7	26.8	5.3	507.3	100
1995	5.9	1.8	26	8.1	30.2	9.5	318.9	100
1996	57.4	8.7	71.3	10.8	61.9	9.4	660.9	100
1997	173.7	20.5	0	0	155	18.3	847.1	100
1998	61.5	12.7	3.8	0.8	42.8	8.8	485.2	100
1999	53.5	6.7	5.3	0.7	109.5	13.8	794.1	100
2000	141.2	9.2	7.3	0.5	77.1	5	1541	100
2001								
2002								
2003								
2004								
2005								
2006								
2007								
2008								

Sources: General Authority for Information and Documentation; Council of General Planning (the Ministry of Planning), Central Bank of Libya, IMF, World Bank; Privatization and Investment Board.

Table A(7)

The capital fixed formation in Agriculture, Manufacturing and Oil sectors and their share in Total capital fixed formation during the period 1970-2008.

The value in million LD at current price

year	CFF in Agriculture	Growth rate of CFF in agriculture	CFF in manufacturing sector	Growth rate of CFF in manufacturing sector	CFF in Oil sector	Growth rate of CFF in oil	Total Capital Fixed Formation	Growth rate of TCFF
1970	11.6	-	9.4	-	93.0	-	242.7	-
1971	33.6	189.6	30.5	224.4	28.5	-69.3	287.9	18.6
1972	37.9	12.7	45.9	50.4	29.5	3.5	436.5	51.6
1973	79.4	109.4	75.2	63.4	32.3	9.4	636.2	45.7
1974	154.1	94.0	127.3	69.2	22.1	-31.5	979.4	53.9
1975	149.9	-2.7	121.5	-4.5	26.1	18.1	1054.7	7.6
1976	170.9	14.0	171.2	40.9	24.2	-7.3	1225.9	16.2
1977	188.4	10.2	164.6	-3.8	45.4	87.6	1368.3	11.6
1978	217.5	15.4	163.2	-0.8	99.1	118.3	1532.0	11.9
1979	234.2	7.6	269.8	65.3	87.4	-11.8	1955.3	27.6
1980	336.4	43.6	429.1	59.0	171.7	96.4	2756.8	40.9
1981	350.3	4.1	498.8	16.2	156.2	-9.0	2660.3	-3.5
1982	237.5	-32.2	348.1	-30.2	147.7	-5.4	2771.5	4.1
1983	208.3	-12.3	398.8	14.5	327.9	122.0	2524.3	-8.9
1984	190.4	-8.5	418.1	4.8	171.7	-47.6	2127.7	-15.7
1985	120.5	-36.7	215.1	-48.5	145.8	-15.1	1558.1	-26.7
1986	82.3	-31.7	178.4	-17.0	143.2	-1.7	1375.9	-11.6
1987	71.6	-13.0	135.0	-24.3	146.2	2.1	949.9	-30.9
1988	71.8	0.27	158.8	17.6	146.6	0.2	1049.8	10.5
1989	112.8	57.1	82.3	-48.1	185.5	26.5	1156.8	10.1
1990	174.1	54.3	43.9	-46.6	240.7	29.7	1135.1	-1.8
1991	30.1	-82.7	37.6	-14.3	198.7	-17.4	1034.3	-8.8
1992	85.0	182.3	67.6	79.7	244.5	23.0	1007.8	-2.5
1993	521.4	513.4	122.5	81.2	405.9	66.0	1503.7	49.2
1994	410.0	-21.4	171.7	40.1	365.1	-10.0	1622.4	7.8
1995	401.9	-1.9	162.4	-5.4	154.1	-57.7	1244.6	-23.2
1996	436.4	8.6	301.9	85.8	109.1	-29.2	1639.7	31.7
1997	649.1	48.7	82.8	-72.5	127.3	16.6	1684.5	2.7
1998	345.5	-46.7	131.0	58.2	234.0	83.8	1396.6	-17.0
1999	257.5	-25.5	93.5	-28.6	297.7	27.2	1536.0	9.9
2000	508.7	97.5	40.3	-56.8	200.0	-32.8	2281.2	48.5
2001	369.9	-27.3	80.4	99.5	200.0	0	6688.5	193.2
2002	1351.0	265.2	478.0	494.5	949.0	374.5	9707.6	45.1
2003	906.0	-32.9	441.0	-7.7	1153.0	21.4	9974.0	2.7
2004	676.0	-25.3	471.0	6.8	1238.0	7.3	10682.7	7.1
2005	1227.0	81.5	480.0	1.9	1664.0	34.4	13331.3	24.7
2006	1127.0	-8.1	581.0	21.0	1747.0	4.9	14515.6	8.8
2007	1273.5		650.7					
2008	1439.0		728.8					

Sources: General Authority for Information and Documentation; Council of General Planning (the Ministry of Planning), Central Bank of Libya, IMF, World Bank; Privatization and Investment Board.

CFF= Capital Fixed Formation.
TCFF= Total Capital Fixed Formation.
L.D= Libyan dinar.
Notes. Value of fixed capital formation (I) for the period 2007-2008 are estimated and obtained from the following equation:-
$B \cdot (1+X)^N = E$
E= value of variable in ending year.
B = value of variable in beginning year.
X = growth rate value
N = number of years between beginning and ending year.
For example, if the beginning year is 1970 and the ending year is 1983, then N = 13.

Table A(8)

The GDP value in current and constant prices and general price index of 1980

The value in million L.D

years	*GDP value at current prices*	*general price index*	*The real GDP value*	*Annual growth rate of the real GDP*
1970	1288.3	0.382	3372.5	-
1971	1586.5	0.491	3231.2	-4
1972	1753.0	0.463	3786.2	17
1973	2182.5	0.442	4937.8	30
1974	3795.7	0.468	8110.5	64
1975	3674.3	0.495	7422.8	-8
1976	4768.1	0.540	8829.8	19
1977	5612.7	0.610	9201.1	4
1978	5496.1	0.685	8023.5	-13
1979	7603.0	0.842	9029.7	12
1980	10553.8	1.00	10553.8	16
1981	8798.8	1.036	8493.1	-19
1982	8932.4	1.159	7706.9	-9
1983	5811.7	1.281	6644.6	-13
1984	7804.7	1.441	5416.2	-18
1985	7852.1	1.573	4991.8	-8
1986	6760.7	1.625	4283.5	-14
1987	6011.6	1.696	3544.6	-17
1988	6186	1.749	3536.9	-0.2
1989	7191	1.771	4060.4	14
1990	8246.8	1.924	4286.3	5
1991	8757.3	2.150	4073.2	-5
1992	9231.9	2.472	3734.6	-8
1993	9137.7	2.966	3080.8	-17
1994	9670.8	3.796	2547.6	-17
1995	10672.3	4.745	2249.2	-11
1996	12327.3	5.695	2164.6	-4
1997	13800.5	6.834	2019.4	-7
1998	12610.6	5.880	2144.7	6
1999	14075.2	6.680	2107.1	-2
2000	17620.2	6.480	2719.2	29
2001	18079.1	5.910	3059.1	12
2002	25914.1	5.330	4861.9	59
2003	37360.7	5.220	7157.2	47
2004	48105.4	5.100	9432.4	32
2005	66450.7	5.200	12779	35
2006	80729.9	5.190	15554.9	21
2007	89260.3	5.730	15577.7	0.1
2008	105728.4	6.450	16392	5

Sources: General Authority for Information and Documentation; Council of General Planning (the Ministry of Planning), Central Bank of Libya, IMF, World Bank; Privatization and Investment Board.

Table A(9)

Capita stock and its composition during the study period

The value in million L.D and at current prices.

years	Agricultural sector			industrial sector			Oil sector		
	K_{t-1}	C	I_t	K_{t-1}	C	I_t	K_{t-1}	C	I_t
1970	122.9	2.0	11.6	79.3	2.3	9.4	461.2	62.3	93
1971	154.5	2.0	33.6	105.2	4.6	30.5	439.4	50.3	28.5
1972	189.9	2.5	37.9	145.8	5.3	45.9	416.9	52.0	29.5
1973	266.6	2.7	79.4	215.4	5.6	75.2	408.2	41.0	32.3
1974	417.5	3.2	154.1	334.6	8.1	127.3	375.7	54.6	22.1
1975	561.4	6.0	149.9	446	10.1	121.5	346.5	55.3	26.1
1976	724.3	8.0	170.9	603.9	13.3	171.2	312	58.7	24.2
1977	902.3	10.4	188.4	753.6	14.9	164.6	305.8	51.6	45.4
1978	1105.3	14.5	217.5	900	16.8	163.2	348.7	56.2	99.1
1979	1318.4	21.1	234.2	1151.3	18.5	269.8	396.1	40.0	87.4
1980	1630.3	24.5	336.4	1555.6	24.8	429.1	494.5	73.3	171.7
1981	1955.3	25.3	350.3	2028.1	26.3	498.8	544.7	106	156.2
1982	2164	28.8	237.5	2346.4	29.8	348.1	601.6	90.8	147.7
1983	2341.8	30.5	208.3	2712.9	32.3	398.8	838.1	91.4	327.9
1984	2501.2	31.0	190.4	3096	35.0	418.1	915.7	94.1	171.7
1985	2588.5	33.2	120.5	3268.4	42.7	215.1	961.4	100.1	145.8
1986	2632.6	38.2	82.3	3357.8	89.0	178.4	1029.6	75.0	143.2
1987	2663.2	41.0	71.6	3387.1	105.7	135.0	1098.3	77.5	146.2
1988	2692.3	42.7	71.8	3427.9	118.0	158.8	1160.6	84.3	146.6
1989	2760.6	44.5	112.8	3388.5	121.7	82.3	1247.4	98.7	185.5
1990	2885.7	49.0	174.1	3302.5	129.9	43.9	1373.7	114.4	240.7
1991	2860.7	55.1	30.1	3207.4	132.7	37.6	1460.6	111.8	198.7
1992	2881.7	64.0	85.0	3118.8	156.2	67.6	1597.2	107.9	244.5
1993	3328.3	74.8	521.4	3054.7	186.6	122.5	1873.9	129.2	405.9
1994	3651.4	86.9	410.0	3035	191.4	171.7	2078.4	160.6	365.1
1995	3956.4	96.9	401.9	2979.9	217.5	162.4	2002.4	230.1	154.1
1996	4282.9	109.9	436.4	3067.7	214.1	301.9	1899.4	212.1	109.1
1997	4806.4	125.6	649.1	2938.7	211.8	82.8	1839.3	187.4	127.3
1998	5007.6	144.3	345.5	2851.4	218.3	131.0	1892.5	180.8	234
1999	5103.3	161.8	257.5	2714	230.9	93.5	2026.1	164.1	297.7
2000	5451.3	160.7	508.7	2511.6	242.7	40.3	2043.1	183.0	200
2001	5790.3	30.9	369.9	2514.6	77.4	80.4	2115.11	127.99	200
2002	7111	30.3	1351.0	2902	90.6	478.0	2932.08	132.03	949
2003	7986	31.0	906.0	3251	92.0	441.0	3949.45	135.63	1153
2004	8630.8	31.2	676.0	3618.1	103.9	471.0	5049.07	138.38	1238
2005	9824.1	33.7	1227.0	4086.7	11.4	480.0	6570.67	142.4	1664
2006	10921	30.1	1127.0	4546.4	121.3	581.0	8171.15	146.5	1747
2007	12162.7	31.8	1273.5	5114.9	82.2	650.7	9944.333	113.5	1886.7
2008	13569.7	32.0	1439.0	5761.7	82.0	728.8	11876.34	105.6	2037.6

I= Gross Fixed Formation.

C= fixed capital consumption depreciation

K_t = capital stock and was calculated from table (9) using equation (4-1).

Table A(10)

The real value of variables used to estimate the production functions in the agricultural and manufacturing sectors during the period 1970-2008.

The value in million L.D
The number of labour in thousand.

years	Agricultural sector			Industrial sector		
	GDP	K_t	L	GDP	K_t	L
1970	86.6	321.7	126	58.9	207.5	20.4
1971	67.2	314.7	127	49.9	214.2	21.4
1972	94.2	410.1	127.7	69.1	314.9	22.9
1973	135.7	603.2	129	99.1	487.3	25.9
1974	138.2	892.1	131.4	117.5	714.9	29.3
1975	167.5	1134.1	133.4	132.3	901.0	32.9
1976	184.6	1341.3	141.2	167.8	1118.3	37.4
1977	147.5	1479.1	144.9	204.4	1235.4	41.5
1978	178.2	1613.5	147.9	217.1	1313.8	47.4
1979	166.7	1565.8	150.1	220.7	1367.3	52.8
1980	236.4	1630.3	153.4	210.4	1555.6	58
1981	264.1	1887.3	162.4	243.6	1957.6	64
1982	246.5	1867.1	167.5	229.3	2024.5	73.7
1983	236.5	1828.1	173	256.9	2117.7	80.5
1984	224.1	1735.7	185.5	250.6	2148.5	72
1985	217.5	1645.6	177	268.1	2077.8	75
1986	236.7	1620.1	178.5	221.3	2066.3	77
1987	242.5	1570.3	180	197.2	1997.1	79
1988	242.0	1539.3	186.9	227.1	1959.9	85.8
1989	248.3	1558.8	191.6	232.8	1913.3	92.2
1990	251.0	1499.8	188.9	237.8	1716.4	99.4
1991	252.3	1330.5	189.6	221.4	1491.8	101.1
1992	254.9	1165.7	195.7	224.5	1261.6	105.4
1993	239.0	1122.1	201.2	236	1029.9	112.6
1994	218.1	961.9	206	159.1	799.5	120.5
1995	196.7	833.8	212.7	156.6	628.0	124.5
1996	188.7	752.0	219.5	123.4	538.6	128.5
1997	185.4	703.3	219.2	119.8	430.0	147.8
1998	237.1	851.6	225.1	132.5	484.9	156.8
1999	217.1	763.9	232	129.2	406.3	163.7
2000	222.2	841.2	239.1	150.1	387.6	169.6
2001	235.5	979.7	113.2	148.5	425.5	115.8
2002	253.1	1334.1	107.2	152.5	544.5	118.7
2003	263.6	1529.8	102.1	146.4	622.8	121.6
2004	282.2	1692.3	109.2	149.2	709.4	126.2
2005	298.9	1889.2	117.0	153.6	785.9	131.2
2006	316.6	2104.2	125.8	155.4	875.9	136.3
2007	332.5	2122.6	67.9	142.2	892.6	128.5
2008	313.3	2103.8	51.00	127.5	893.3	127.2

K_t = Real net capital stock of Libya and was calculated by research from table (8) and table (9).

Table A (11)

Exchange rate in $=L.D during the period of 1970-2007

year	*$=L.D*
1970	0.35
1971	0.32
1972	0.32
1973	0.29
1974	0.29
1975	0.29
1976	0.29
1977	0.29
1978	0.29
1979	0.29
1980	0.29
1981	0.29
1982	0.29
1983	0.29
1984	0.29
1985	0.29
1986	0.31
1987	0.27
1988	0.28
1989	0.29
1990	0.26
1991	0.26
1992	0.30
1993	0.32
1994	0.43
1995	0.42
1996	0.44
1997	0.44
1998	0.45
1999	0.46
2000	0.54
2001	0.64
2002	1.22
2003	1.30
2004	1.25
2005	1.35
2006	1.31
2007	1.26

L.D= Libyan currency

Sources: Different issues of Central Bank of Libya, IMF and World Bank.

Appendix (B) Co-Integration Test

Table B(1)

Co-integration with unrestricted intercepts and no trend of variables included in the Co-integrating vector of agricultural sector- at 5%.

Sample (adjusted): 1972 2008
Included observations: 37 after adjustments
Trend assumption: Linear deterministic trend
Series: lnQ lnK lnL
Lags interval (in first differences): 1 to 1

Unrestricted Co integration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.525408	33.06252	29.79707	0.0203
At most 1	0.137727	5.486444	15.49471	0.7552
At most 2	9.91E-05	0.003667	3.841466	0.9506

Trace test indicates 1 co integrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Co integration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.525408	27.57608	21.13162	0.0054
At most 1	0.137727	5.482777	14.26460	0.6801
At most 2	9.91E-05	0.003667	3.841466	0.9506

Max-eigenvalue test indicates 1 co integrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Table B(2)

Co-integration with unrestricted intercepts and with trend of variables included in the Co-integrating vector of agricultural sector- at 5%.

Sample (adjusted): 1972 2008
Included observations: 37 after adjustments
Trend assumption: Linear deterministic trend (restricted)
Series: lnQ lnK lnL
Lags interval (in first differences): 1 to 1

Unrestricted Co integration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.540133	47.43327	42.91525	0.0165
At most 1	0.309180	18.69104	25.87211	0.2994
At most 2	0.126534	5.005601	12.51798	0.5956

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Co integration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.540133	28.74223	25.82321	0.0201
At most 1	0.309180	13.68544	19.38704	0.2759
At most 2	0.126534	5.005601	12.51798	0.5956

Max-eigenvalue test indicates 1 co integrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Table B(3)

Co-integration with unrestricted intercepts and no trend of variables included in the Co-integrating vector of agricultural sector- at 10%.

Sample (adjusted): 1972 2008
Included observations: 37 after adjustments
Trend assumption: Linear deterministic trend
Series: lnQ lnK lnL
Lags interval (in first differences): 1 to 1

Unrestricted Co integration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.1 Critical Value	Prob.**
None *	0.525408	33.06252	27.06695	0.0203
At most 1	0.137727	5.486444	13.42878	0.7552
At most 2	9.91E-05	0.003667	2.705545	0.9506

Trace test indicates 1 co integrating eqn(s) at the 0.1 level
* denotes rejection of the hypothesis at the 0.1 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Co integration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.1 Critical Value	Prob.**
None *	0.525408	27.57608	18.89282	0.0054
At most 1	0.137727	5.482777	12.29652	0.6801
At most 2	9.91E-05	0.003667	2.705545	0.9506

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.1 level
* denotes rejection of the hypothesis at the 0.1 level
**MacKinnon-Haug-Michelis (1999) p-values

Table B(4)

Co-integration with unrestricted intercepts and with trend of variables included in the Co-integrating vector of agricultural sector- at 10%.

Sample (adjusted): 1972 2008
Included observations: 37 after adjustments
Trend assumption: Linear deterministic trend (restricted)
Series: lnQ lnK lnL
Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.1 Critical Value	Prob.**
None *	0.540133	47.43327	39.75526	0.0165
At most 1	0.309180	18.69104	23.34234	0.2994
At most 2	0.126534	5.005601	10.66637	0.5956

Trace test indicates 1 cointegrating eqn(s) at the 0.1 level
* denotes rejection of the hypothesis at the 0.1 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.1 Critical Value	Prob.**
None *	0.540133	28.74223	23.44089	0.0201
At most 1	0.309180	13.68544	17.23410	0.2759
At most 2	0.126534	5.005601	10.66637	0.5956

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.1 level
* denotes rejection of the hypothesis at the 0.1 level
**MacKinnon-Haug-Michelis (1999) p-values

Table B(5)

Co-integration with unrestricted intercepts and no trend of variables included in the Co-integrating vector of agricultural sector- at 5%.

Sample (adjusted): 1972 2008
Included observations: 37 after adjustments
Trend assumption: Linear deterministic trend
Series: *LNQ* *LN K* *lnL*
(LNK-LNL)^2

Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.558645	60.25850	47.85613	0.0023
At most 1 *	0.348370	29.99600	29.79707	0.0474
At most 2	0.229095	14.14970	15.49471	0.0789
At most 3 *	0.115059	4.522660	3.841466	0.0334

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.558645	30.26251	27.58434	0.0221
At most 1	0.348370	15.84630	21.13162	0.2340
At most 2	0.229095	9.627038	14.26460	0.2376
At most 3 *	0.115059	4.522660	3.841466	0.0334

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Table B(6)

Co-integration with unrestricted intercepts and with trend of variables included in the Co-integrating vector of agricultural sector- at 5%.

Series: LNQ LN K LN L (LNK-LNL)^2

Sample (adjusted): 1972 2008
Included observations: 37 after adjustments
Trend assumption: Linear deterministic trend (restricted)

Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.569825	69.61803	63.87610	0.0152
At most 1	0.397078	38.40622	42.91525	0.1314
At most 2	0.272162	19.68541	25.87211	0.2423
At most 3	0.192944	7.931385	12.51798	0.2573

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None	0.569825	31.21182	32.11832	0.0642
At most 1	0.397078	18.72081	25.82321	0.3244
At most 2	0.272162	11.75402	19.38704	0.4384
At most 3	0.192944	7.931385	12.51798	0.2573

Max-eigenvalue test indicates no cointegration at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Table B(7)

Co-integration with unrestricted intercepts and no trend of variables included in the Co-integrating vector of agricultural sector- at 10%.

***Series: LNQ** LN K LN L (LNK-LNL)^2*

Sample (adjusted): 1972 2008
Included observations: 37 after adjustments
Trend assumption: Linear deterministic trend

Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.1 Critical Value	Prob.**
None *	0.558645	60.25850	44.49359	0.0023
At most 1 *	0.348370	29.99600	27.06695	0.0474
At most 2 *	0.229095	14.14970	13.42878	0.0789
At most 3 *	0.115059	4.522660	2.705545	0.0334

Trace test indicates 4 cointegrating eqn(s) at the 0.1 level
* denotes rejection of the hypothesis at the 0.1 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.1 Critical Value	Prob.**
None *	0.558645	30.26251	25.12408	0.0221
At most 1	0.348370	15.84630	18.89282	0.2340
At most 2	0.229095	9.627038	12.29652	0.2376
At most 3 *	0.115059	4.522660	2.705545	0.0334

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.1 level
* denotes rejection of the hypothesis at the 0.1 level
**MacKinnon-Haug-Michelis (1999) p-values

Table B(8)

Co-integration with unrestricted intercepts and with trend of variables included in the Co-integrating vector of agricultural sector- at 10%.

Series: LNQ LN K LN L (LNK-LNL)²

Sample (adjusted): 1972 2008
Included observations: 37 after adjustments
Trend assumption: Linear deterministic trend (restricted)

Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.1 Critical Value	Prob.**
None *	0.569825	69.61803	60.08629	0.0152
At most 1	0.397078	38.40622	39.75526	0.1314
At most 2	0.272162	19.68541	23.34234	0.2423
At most 3	0.192944	7.931385	10.66637	0.2573

Trace test indicates 1 cointegrating eqn(s) at the 0.1 level
* denotes rejection of the hypothesis at the 0.1 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.1 Critical Value	Prob.**
None *	0.569825	31.21182	29.54003	0.0642
At most 1	0.397078	18.72081	23.44089	0.3244
At most 2	0.272162	11.75402	17.23410	0.4384
At most 3	0.192944	7.931385	10.66637	0.2573

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.1 level
* denotes rejection of the hypothesis at the 0.1 level
**MacKinnon-Haug-Michelis (1999) p-values

Table B(9)

Co-integration with unrestricted intercepts and no trend of variables included in the Co-integrating vector of agricultural sector- at 5%.

Series:LN(Q/L) LN(K/L) (LN(K/L))^2

Sample (adjusted): 1972 2008
Included observations: 37 after adjustments
Trend assumption: Linear deterministic trend

Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None	0.384941	29.48598	29.79707	0.0543
At most 1	0.222072	11.50258	15.49471	0.1824
At most 2	0.058008	2.211078	3.841466	0.1370

Trace test indicates no cointegration at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None	0.384941	17.98340	21.13162	0.1305
At most 1	0.222072	9.291506	14.26460	0.2627
At most 2	0.058008	2.211078	3.841466	0.1370

Max-eigenvalue test indicates no cointegration at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Table B(10)

Co-integration with unrestricted intercepts and with trend of variables included in the Co-integrating vector of agricultural sector- at 5%.

Series:LN(Q/L) LN(K/L) $(LN(K/L))^2$

Sample (adjusted): 1972 2008
Included observations: 37 after adjustments
Trend assumption: Linear deterministic trend (restricted)

Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.440565	43.41067	42.91525	0.0446
At most 1	0.316071	21.92002	25.87211	0.1436
At most 2	0.191465	7.863674	12.51798	0.2630

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None	0.440565	21.49064	25.82321	0.1686
At most 1	0.316071	14.05635	19.38704	0.2504
At most 2	0.191465	7.863674	12.51798	0.2630

Max-eigenvalue test indicates no cointegration at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Table B(11)

Co-integration with unrestricted intercepts and no trend of variables included in the Co-integrating vector of agricultural sector- at 10%.

Series:LN(Q/L)   LN(K/L)   (LN(K/L))^2

AT 10%

Sample (adjusted): 1972 2008
Included observations: 37 after adjustments
Trend assumption: Linear deterministic trend

Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.1 Critical Value	Prob.**
None *	0.384941	29.48598	27.06695	0.0543
At most 1	0.222072	11.50258	13.42878	0.1824
At most 2	0.058008	2.211078	2.705545	0.1370

Trace test indicates 1 cointegrating eqn(s) at the 0.1 level
* denotes rejection of the hypothesis at the 0.1 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.1 Critical Value	Prob.**
None	0.384941	17.98340	18.89282	0.1305
At most 1	0.222072	9.291506	12.29652	0.2627
At most 2	0.058008	2.211078	2.705545	0.1370

Max-eigenvalue test indicates no cointegration at the 0.1 level
* denotes rejection of the hypothesis at the 0.1 level
**MacKinnon-Haug-Michelis (1999) p-values

Table B(12)

Co-integration with unrestricted intercepts and with trend of variables included in the Co-integrating vector of agricultural sector- at 10%.

Series:LN(Q/L)　LN(K/L)　$(LN(K/L))^2$

Sample (adjusted): 1972 2008
Included observations: 37 after adjustments
Trend assumption: Linear deterministic trend (restricted)

Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.1 Critical Value	Prob.**
None *	0.440565	43.41067	39.75526	0.0446
At most 1	0.316071	21.92002	23.34234	0.1436
At most 2	0.191465	7.863674	10.66637	0.2630

Trace test indicates 1 cointegrating eqn(s) at the 0.1 level
* denotes rejection of the hypothesis at the 0.1 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.1 Critical Value	Prob.**
None	0.440565	21.49064	23.44089	0.1686
At most 1	0.316071	14.05635	17.23410	0.2504
At most 2	0.191465	7.863674	10.66637	0.2630

Max-eigenvalue test indicates no cointegration at the 0.1 level
* denotes rejection of the hypothesis at the 0.1 level
**MacKinnon-Haug-Michelis (1999) p-values

Table B(13)

Co-integration with unrestricted intercepts and no trend of variables included in the Co-integrating vector of agricultural sector- at 5%.

Series: LN(Q/L) LN(K/L)

Sample (adjusted): 1972 2008
Included observations: 37 after adjustments
Trend assumption: Linear deterministic trend

Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None	0.096856	3.924942	15.49471	0.9095
At most 1	0.004197	0.155624	3.841466	0.6932

Trace test indicates no cointegration at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None	0.096856	3.769317	14.26460	0.8828
At most 1	0.004197	0.155624	3.841466	0.6932

Max-eigenvalue test indicates no cointegration at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Table B(14)

Co-integration with unrestricted intercepts and with trend of variables included in the Co-integrating vector of agricultural sector- at 5%.

Series: LN(Q/L) *LN(K/L)*

Sample (adjusted): 1972 2008
Included observations: 37 after adjustments
Trend assumption: Linear deterministic trend (restricted)

Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None	0.294080	16.02623	25.87211	0.4905
At most 1	0.081385	3.140847	12.51798	0.8594

Trace test indicates no cointegration at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None	0.294080	12.88538	19.38704	0.3374
At most 1	0.081385	3.140847	12.51798	0.8594

Max-eigenvalue test indicates no cointegration at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Table B(15)

Co-integration with unrestricted intercepts and no trend of variables included in the Co-integrating vector of agricultural sector- at 10%.

Series:LN(Q/L) ***LN(K/L)***

Sample (adjusted): 1972 2008
Included observations: 37 after adjustments
Trend assumption: Linear deterministic trend

Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.1 Critical Value	Prob.**
None	0.096856	3.924942	13.42878	0.9095
At most 1	0.004197	0.155624	2.705545	0.6932

Trace test indicates no cointegration at the 0.1 level
* denotes rejection of the hypothesis at the 0.1 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.1 Critical Value	Prob.**
None	0.096856	3.769317	12.29652	0.8828
At most 1	0.004197	0.155624	2.705545	0.6932

Max-eigenvalue test indicates no cointegration at the 0.1 level
* denotes rejection of the hypothesis at the 0.1 level
**MacKinnon-Haug-Michelis (1999) p-values

Table B(16)

Co-integration with unrestricted intercepts and with trend of variables included in the Co-integrating vector of agricultural sector- at 10%.

Series: LN(Q/L) ***LN(K/L)***

Sample (adjusted): 1972 2008
Included observations: 37 after adjustments
Trend assumption: Linear deterministic trend (restricted)

Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.1 Critical Value	Prob.**
None	0.294080	16.02623	23.34234	0.4905
At most 1	0.081385	3.140847	10.66637	0.8594

Trace test indicates no cointegration at the 0.1 level
* denotes rejection of the hypothesis at the 0.1 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.1 Critical Value	Prob.**
None	0.294080	12.88538	17.23410	0.3374
At most 1	0.081385	3.140847	10.66637	0.8594

Max-eigenvalue test indicates no cointegration at the 0.1 level
* denotes rejection of the hypothesis at the 0.1 level
**MacKinnon-Haug-Michelis (1999) p-values

Table B(17)

Co-integration with unrestricted intercepts and no trend of variables included in the Co-integrating vector of manufacturing sector- at 5%.

Sample (adjusted): 1972 2008
Included observations: 37 after adjustments

Series: LNQ LNK LNL
Lags interval (in first differences): 1 to 1

Unrestricted Co integration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.542776	38.00236	29.79707	0.0046
At most 1	0.136413	9.046852	15.49471	0.3611
At most 2	0.093215	3.620430	3.841466	0.0571

Trace test indicates 1 co integrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.542776	28.95551	21.13162	0.0032
At most 1	0.136413	5.426423	14.26460	0.6873
At most 2	0.093215	3.620430	3.841466	0.0571

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Table B(18)

Co-integration with unrestricted intercepts and with trend of variables included in the Co-integrating vector of manufacturing sector- at 5%.

Sample (adjusted): 1972 2008
Included observations: 37 after adjustments
Trend assumption: Linear deterministic trend (restricted)
Series: LNQ LNK LNL
Lags interval (in first differences): 1 to 1

Unrestricted Co integration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.546929	45.08577	42.91525	0.0298
At most 1	0.247809	15.79263	25.87211	0.5093
At most 2	0.132433	5.256316	12.51798	0.5600

Trace test indicates 1 co integrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Co integration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.546929	29.29314	25.82321	0.0167
At most 1	0.247809	10.53631	19.38704	0.5617
At most 2	0.132433	5.256316	12.51798	0.5600

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Table B(19)

Co-integration with unrestricted intercepts and no trend of variables included in the Co-integrating vector of manufacturing sector- at 10%.

Sample (adjusted): 1972 2008
Included observations: 37 after adjustments
Trend assumption: Linear deterministic trend
Series: LNQ LNK LNL
Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.1 Critical Value	Prob.**
None *	0.542776	38.00236	27.06695	0.0046
At most 1	0.136413	9.046852	13.42878	0.3611
At most 2 *	0.093215	3.620430	2.705545	0.0571

Trace test indicates 1 cointegrating eqn(s) at the 0.1 level
* denotes rejection of the hypothesis at the 0.1 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.1 Critical Value	Prob.**
None *	0.542776	28.95551	18.89282	0.0032
At most 1	0.136413	5.426423	12.29652	0.6873
At most 2 *	0.093215	3.620430	2.705545	0.0571

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.1 level
* denotes rejection of the hypothesis at the 0.1 level
**MacKinnon-Haug-Michelis (1999) p-values

Table B(20)

Co-integration with unrestricted intercepts and with trend of variables included in the Co-integrating vector of manufacturing sector- at 10%.

Sample (adjusted): 1972 2008
Included observations: 37 after adjustments
Trend assumption: Linear deterministic trend (restricted)
Series: LNQ LNK LNL
Lags interval (in first differences): 1 to 1

Unrestricted Co integration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.1 Critical Value	Prob.**
None *	0.546929	45.08577	39.75526	0.0298
At most 1	0.247809	15.79263	23.34234	0.5093
At most 2	0.132433	5.256316	10.66637	0.5600

Trace test indicates 1 co integrating eqn(s) at the 0.1 level
* denotes rejection of the hypothesis at the 0.1 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Co integration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.1 Critical Value	Prob.**
None *	0.546929	29.29314	23.44089	0.0167
At most 1	0.247809	10.53631	17.23410	0.5617
At most 2	0.132433	5.256316	10.66637	0.5600

Max-eigenvalue test indicates 1 co integrating eqn(s) at the 0.1 level
* denotes rejection of the hypothesis at the 0.1 level
**MacKinnon-Haug-Michelis (1999) p-values

Table B(21)

Co-integration with unrestricted intercepts and no trend of variables included in the Co-integrating vector of manufacturing sector- at 5%.

Series: LNQ LNK LNL (LNK-LNL)2

Sample (adjusted): 1972 2008
Included observations: 37 after adjustments
Trend assumption: Linear deterministic trend

Lags interval (in first differences): 1 to 1

Unrestricted Co integration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.636482	58.77021	47.85613	0.0034
At most 1	0.253907	21.32898	29.79707	0.3374
At most 2	0.192761	10.49148	15.49471	0.2448
At most 3	0.067064	2.568479	3.841466	0.1090

Trace test indicates 1 co integrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Table B(22)

Co-integration with unrestricted intercepts and with trend of variables included in the Co-integrating vector of manufacturing sector- at 5%.

Series: LNQ LNK LNL (LNK-LNL)2

Sample (adjusted): 1972 2008
Included observations: 37 after adjustments
Trend assumption: Linear deterministic trend (restricted)

Lags interval (in first differences): 1 to 1

Unrestricted Co integration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.638238	72.48230	63.87610	0.0079
At most 1	0.375170	34.86188	42.91525	0.2508
At most 2	0.245544	17.46168	25.87211	0.3813
At most 3	0.173189	7.036610	12.51798	0.3407

Trace test indicates 1 co integrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Co integration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.638238	37.62042	32.11832	0.0096
At most 1	0.375170	17.40020	25.82321	0.4246
At most 2	0.245544	10.42506	19.38704	0.5735
At most 3	0.173189	7.036610	12.51798	0.3407

Max-eigenvalue test indicates 1 co integrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Table B(23)

Co-integration with unrestricted intercepts and no trend of variables included in the Co-integrating vector of manufacturing sector- at 10%.

Series:LNQ LNK LNL (LNK-LNL)2

Sample (adjusted): 1972 2008
Included observations: 37 after adjustments
Trend assumption: Linear deterministic trend

Lags interval (in first differences): 1 to 1

Unrestricted Co integration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.1 Critical Value	Prob.**
None *	0.636482	58.77021	44.49359	0.0034
At most 1	0.253907	21.32898	27.06695	0.3374
At most 2	0.192761	10.49148	13.42878	0.2448
At most 3	0.067064	2.568479	2.705545	0.1090

Trace test indicates 1 co integrating eqn(s) at the 0.1 level
* denotes rejection of the hypothesis at the 0.1 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.1 Critical Value	Prob.**
None *	0.636482	37.44123	25.12408	0.0020
At most 1	0.253907	10.83751	18.89282	0.6635
At most 2	0.192761	7.922998	12.29652	0.3866
At most 3	0.067064	2.568479	2.705545	0.1090

Max-eigenvalue test indicates 1 co integrating eqn(s) at the 0.1 level
* denotes rejection of the hypothesis at the 0.1 level
**MacKinnon-Haug-Michelis (1999) p-values

Table B(24)

Co-integration with unrestricted intercepts and with trend of variables included in the Co-integrating vector of manufacturing sector- at 10%.

Series: LNQ LNK LNL (LNK-LNL)2

Sample (adjusted): 1972 2008
Included observations: 37 after adjustments
Trend assumption: Linear deterministic trend (restricted)

Lags interval (in first differences): 1 to 1

Unrestricted Co integration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.1 Critical Value	Prob.**
None *	0.638238	72.48230	60.08629	0.0079
At most 1	0.375170	34.86188	39.75526	0.2508
At most 2	0.245544	17.46168	23.34234	0.3813
At most 3	0.173189	7.036610	10.66637	0.3407

Trace test indicates 1 co integrating eqn(s) at the 0.1 level
* denotes rejection of the hypothesis at the 0.1 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Co integration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.1 Critical Value	Prob.**
None *	0.638238	37.62042	29.54003	0.0096
At most 1	0.375170	17.40020	23.44089	0.4246
At most 2	0.245544	10.42506	17.23410	0.5735
At most 3	0.173189	7.036610	10.66637	0.3407

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.1 level
* denotes rejection of the hypothesis at the 0.1 level
**MacKinnon-Haug-Michelis (1999) p-values

Table B(25)

Co-integration with unrestricted intercepts and no trend of variables included in the Co-integrating vector of manufacturing sector- at 5%.

Series: LN(Q/L) LN(K/L) (LN(K/L)2

Sample (adjusted): 1972 2008
Included observations: 37 after adjustments
Trend assumption: Linear deterministic trend

Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.446305	33.68486	29.79707	0.0170
At most 1	0.218430	11.81264	15.49471	0.1661
At most 2	0.070222	2.693966	3.841466	0.1007

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.446305	21.87222	21.13162	0.0393
At most 1	0.218430	9.118675	14.26460	0.2764
At most 2	0.070222	2.693966	3.841466	0.1007

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Table B(26)

Co-integration with unrestricted intercepts and with trend of variables included in the Co-integrating vector of manufacturing sector- at 5%.

Series: LN(Q/L) LN(K/L) (LN(K/L)2

Sample (adjusted): 1972 2008
Included observations: 37 after adjustments
Trend assumption: Linear deterministic trend (restricted)

Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.519893	54.62786	42.91525	0.0023
At most 1 *	0.391486	27.47927	25.87211	0.0313
At most 2	0.218037	9.100092	12.51798	0.1743

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.519893	27.14858	25.82321	0.0333
At most 1	0.391486	18.37918	19.38704	0.0696
At most 2	0.218037	9.100092	12.51798	0.1743

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Table B(27)

Co-integration with unrestricted intercepts and no trend of variables included in the Co-integrating vector of manufacturing sector- at 10%.

LN(Q/L) LN(K/L) (LN(K/L)2

Date: 04/14/10 Time: 21:00
Sample (adjusted): 1972 2008
Included observations: 37 after adjustments
Trend assumption: Linear deterministic trend
Series: QL KL KL2
Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.1 Critical Value	Prob.**
None *	0.446305	33.68486	27.06695	0.0170
At most 1	0.218430	11.81264	13.42878	0.1661
At most 2	0.070222	2.693966	2.705545	0.1007

Trace test indicates 1 cointegrating eqn(s) at the 0.1 level
* denotes rejection of the hypothesis at the 0.1 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.1 Critical Value	Prob.**
None *	0.446305	21.87222	18.89282	0.0393
At most 1	0.218430	9.118675	12.29652	0.2764
At most 2	0.070222	2.693966	2.705545	0.1007

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.1 level
* denotes rejection of the hypothesis at the 0.1 level
**MacKinnon-Haug-Michelis (1999) p-values

Table B(28)

Co-integration with unrestricted intercepts and with trend of variables included in the Co-integrating vector of manufacturing sector- at 10%.

Series: LN(Q/L) LN(K/L) (LN(K/L)2

Sample (adjusted): 1972 2008
Included observations: 37 after adjustments
Trend assumption: Linear deterministic trend (restricted)

Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.1 Critical Value	Prob.**
None *	0.519893	54.62786	39.75526	0.0023
At most 1 *	0.391486	27.47927	23.34234	0.0313
At most 2	0.218037	9.100092	10.66637	0.1743

Trace test indicates 2 cointegrating eqn(s) at the 0.1 level
* denotes rejection of the hypothesis at the 0.1 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.1 Critical Value	Prob.**
None *	0.519893	27.14858	23.44089	0.0333
At most 1 *	0.391486	18.37918	17.23410	0.0696
At most 2	0.218037	9.100092	10.66637	0.1743

Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.1 level
* denotes rejection of the hypothesis at the 0.1 level
**MacKinnon-Haug-Michelis (1999) p-values

Table B(29)

Co-integration with unrestricted intercepts and no trend of variables included in the Co-integrating vector of manufacturing sector- at 5%.

Series: LN(Q/L) LN(K/L)

Sample (adjusted): 1972 2008
Included observations: 37 after adjustments
Trend assumption: Linear deterministic trend

Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None	0.268579	14.15484	15.49471	0.0788
At most I	0.067417	2.582510	3.841466	0.1080

Trace test indicates no cointegration at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None	0.268579	11.57233	14.26460	0.1278
At most 1	0.067417	2.582510	3.841466	0.1080

Max-eigenvalue test indicates no cointegration at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Table B(30)

Co-integration with unrestricted intercepts and with trend of variables included in the Co-integrating vector of manufacturing sector- at 5%.

Series: LN(Q/L) LN(K/L)

Sample (adjusted): 1972 2008
Included observations: 37 after adjustments
Trend assumption: Linear deterministic trend (restricted)

Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.411835	29.33886	25.87211	0.0178
At most 1	0.230638	9.701177	12.51798	0.1414

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.411835	19.63769	19.38704	0.0460
At most 1	0.230638	9.701177	12.51798	0.1414

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Table B(31)

Co-integration with unrestricted intercepts and no trend of variables included in the Co-integrating vector of manufacturing sector- at 10%.

LN(Q/L) LN(K/L)

Sample (adjusted): 1972 2008
Included observations: 37 after adjustments
Trend assumption: Linear deterministic trend

Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None	0.268579	14.15484	15.49471	0.0788
At most 1	0.067417	2.582510	3.841466	0.1080

Trace test indicates no cointegration at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None	0.268579	11.57233	14.26460	0.1278
At most 1	0.067417	2.582510	3.841466	0.1080

Max-eigenvalue test indicates no cointegration at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Table B(32)

Co-integration with unrestricted intercepts and with trend of variables included in the Co-integrating vector of manufacturing sector- at 10%.

LN(Q/L) LN(K/L)

Date: 04/14/10 Time: 21:06
Sample (adjusted): 1972 2008
Included observations: 37 after adjustments
Trend assumption: Linear deterministic trend (restricted)
Series: QL KL
Lags interval (in first differences): 1 to 1

Unrestricted Co-integration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.1 Critical Value	Prob.**
None *	0.411835	29.33886	23.34234	0.0178
At most 1	0.230638	9.701177	10.66637	0.1414

Trace test indicates 1 co integrating eqn(s) at the 0.1 level
* denotes rejection of the hypothesis at the 0.1 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Co integration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.1 Critical Value	Prob.**
None *	0.411835	19.63769	17.23410	0.0460
At most 1	0.230638	9.701177	10.66637	0.1414

Max-eigenvalue test indicates 1 co integrating eqn(s) at the 0.1 level
* denotes rejection of the hypothesis at the 0.1 level
**MacKinnon-Haug-Michelis (1999) p-values

Table B(33)

Co-integration with unrestricted intercepts and no trend of variables included in the Co-integrating vector of productive sector- at 5%.

***Series:* LNQ LNK LNL**

Sample (adjusted): 1972 2008
Included observations: 37 after adjustments
Trend assumption: Linear deterministic trend

Lags interval (in first differences): 1 to 1

Unrestricted Co integration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.569201	44.09305	29.79707	0.0006
At most 1	0.189413	12.93480	15.49471	0.1172
At most 2 *	0.130288	5.164930	3.841466	0.0230

Trace test indicates 1 co integrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Co integration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.569201	31.15825	21.13162	0.0014
At most 1	0.189413	7.769874	14.26460	0.4026
At most 2 *	0.130288	5.164930	3.841466	0.0230

Max-eigenvalue test indicates 1 co integrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Table B(34)

Co-integration with unrestricted intercepts and with trend of variables included in the Co-integrating vector of productive sector- at 5%.

Series: LNQ LNK LNL

Sample (adjusted): 1972 2008
Included observations: 37 after adjustments
Trend assumption: Linear deterministic trend (restricted)

Lags interval (in first differences): 1 to 1

Unrestricted Co integration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.581206	48.08676	42.91525	0.0140
At most 1	0.248865	15.88283	25.87211	0.5020
At most 2	0.133329	5.294525	12.51798	0.5547

Trace test indicates 1 co integrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Co integration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.581206	32.20393	25.82321	0.0063
At most 1	0.248865	10.58831	19.38704	0.5562
At most 2	0.133329	5.294525	12.51798	0.5547

Max-eigenvalue test indicates 1 co integrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Table B(35)

Co-integration with unrestricted intercepts and no trend of variables included in the Co-integrating vector of productive sector- at 10%.

Series: LNQ LNK LNL

Sample (adjusted): 1972 2008
Included observations: 37 after adjustments
Trend assumption: Linear deterministic trend

Lags interval (in first differences): 1 to 1

Unrestricted Co integration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.1 Critical Value	Prob.**
None *	0.569201	44.09305	27.06695	0.0006
At most 1	0.189413	12.93480	13.42878	0.1172
At most 2 *	0.130288	5.164930	2.705545	0.0230

Trace test indicates 1 co integrating eqn(s) at the 0.1 level
* denotes rejection of the hypothesis at the 0.1 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Co integration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.1 Critical Value	Prob.**
None *	0.569201	31.15825	18.89282	0.0014
At most 1	0.189413	7.769874	12.29652	0.4026
At most 2 *	0.130288	5.164930	2.705545	0.0230

Max-eigenvalue test indicates 1 co integrating eqn(s) at the 0.1 level
* denotes rejection of the hypothesis at the 0.1 level
**MacKinnon-Haug-Michelis (1999) p-values

Table B(36)

Co-integration with unrestricted intercepts and with trend of variables included in the Co-integrating vector of productive sector- at 10%.

Series: LNQ LNK LNL

Sample (adjusted): 1972 2008
Included observations: 37 after adjustments
Trend assumption: Linear deterministic trend (restricted)

Lags interval (in first differences): 1 to 1

Unrestricted Co integration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.1 Critical Value	Prob.**
None *	0.581206	48.08676	39.75526	0.0140
At most 1	0.248865	15.88283	23.34234	0.5020
At most 2	0.133329	5.294525	10.66637	0.5547

Trace test indicates 1 co integrating eqn(s) at the 0.1 level
* denotes rejection of the hypothesis at the 0.1 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Co integration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.1 Critical Value	Prob.**
None *	0.581206	32.20393	23.44089	0.0063
At most 1	0.248865	10.58831	17.23410	0.5562
At most 2	0.133329	5.294525	10.66637	0.5547

Max-eigenvalue test indicates 1 co integrating eqn(s) at the 0.1 level
* denotes rejection of the hypothesis at the 0.1 level
**MacKinnon-Haug-Michelis (1999) p-values

Table B(37)

Co-integration with unrestricted intercepts and no trend of variables included in the Co-integrating vector of productive sector- at 5%.

Series: LNQ LNK LNL (LNK-LNL)2

Sample (adjusted): 1972 2008
Included observations: 37 after adjustments
Trend assumption: Linear deterministic trend

Lags interval (in first differences): 1 to 1

Unrestricted Co integration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.597709	56.11569	47.85613	0.0069
At most 1	0.263845	22.42422	29.79707	0.2755
At most 2	0.184246	11.09060	15.49471	0.2060
At most 3	0.091630	3.555846	3.841466	0.0593

Trace test indicates 1 co integrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Co integration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.597709	33.69147	27.58434	0.0072
At most 1	0.263845	11.33362	21.13162	0.6140
At most 2	0.184246	7.534755	14.26460	0.4280
At most 3	0.091630	3.555846	3.841466	0.0593

Max-eigenvalue test indicates 1 co integrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Table B(38)

Co-integration with unrestricted intercepts and with trend of variables included in the Co-integrating vector of productive sector- at 5%.

Series: LNQ LNK LNL (LNK-LNL)2

Sample (adjusted): 1972 2008
Included observations: 37 after adjustments
Trend assumption: Linear deterministic trend (restricted)

Lags interval (in first differences): 1 to 1

Unrestricted Co integration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.634618	64.96683	63.87610	0.0404
At most 1	0.273625	27.71478	42.91525	0.6391
At most 2	0.241148	15.88629	25.87211	0.5017
At most 3	0.142223	5.676192	12.51798	0.5025

Trace test indicates 1 co integrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Co integration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.634618	37.25205	32.11832	0.0108
At most 1	0.273625	11.82849	25.82321	0.8831
At most 2	0.241148	10.21010	19.38704	0.5964
At most 3	0.142223	5.676192	12.51798	0.5025

Max-eigenvalue test indicates 1 co integrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Table B(39)

Co-integration with unrestricted intercepts and no trend of variables included in the Co-integrating vector of productive sector- at 10%.

Series: LNQ LNK LNL (LNK-LNL)2

Sample (adjusted): 1972 2008
Included observations: 37 after adjustments
Trend assumption: Linear deterministic trend

Lags interval (in first differences): 1 to 1

Unrestricted Co integration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.1 Critical Value	Prob.**
None *	0.597709	56.11569	44.49359	0.0069
At most 1	0.263845	22.42422	27.06695	0.2755
At most 2	0.184246	11.09060	13.42878	0.2060
At most 3 *	0.091630	3.555846	2.705545	0.0593

Trace test indicates 1 co integrating eqn(s) at the 0.1 level
* denotes rejection of the hypothesis at the 0.1 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Co integration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.1 Critical Value	Prob.**
None *	0.597709	33.69147	25.12408	0.0072
At most 1	0.263845	11.33362	18.89282	0.6140
At most 2	0.184246	7.534755	12.29652	0.4280
At most 3 *	0.091630	3.555846	2.705545	0.0593

Max-eigenvalue test indicates 1 co integrating eqn(s) at the 0.1 level
* denotes rejection of the hypothesis at the 0.1 level
**MacKinnon-Haug-Michelis (1999) p-values

Table B(40)

Co-integration with unrestricted intercepts and with trend of variables included in the Co-integrating vector of productive sector- at 10%.

Series: LNQ LNK LNL (LNK-LNL)2

Sample (adjusted): 1972 2008
Included observations: 37 after adjustments
Trend assumption: Linear deterministic trend (restricted)

Lags interval (in first differences): 1 to 1

Unrestricted Co integration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.1 Critical Value	Prob.**
None *	0.634618	64.96683	60.08629	0.0404
At most 1	0.273625	27.71478	39.75526	0.6391
At most 2	0.241148	15.88629	23.34234	0.5017
At most 3	0.142223	5.676192	10.66637	0.5025

Trace test indicates 1 cointegrating eqn(s) at the 0.1 level
* denotes rejection of the hypothesis at the 0.1 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Co integration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.1 Critical Value	Prob.**
None *	0.634618	37.25205	29.54003	0.0108
At most 1	0.273625	11.82849	23.44089	0.8831
At most 2	0.241148	10.21010	17.23410	0.5964
At most 3	0.142223	5.676192	10.66637	0.5025

Max-eigenvalue test indicates 1 co integrating eqn(s) at the 0.1 level
* denotes rejection of the hypothesis at the 0.1 level
**MacKinnon-Haug-Michelis (1999) p-values

Table B(41)

Co-integration with unrestricted intercepts and no trend of variables included in the Co-integrating vector of productive sector- at 5%.

Series: LN(Q/L) LN(K/L) (LN(K/L))2

Sample (adjusted): 1972 2008
Included observations: 37 after adjustments
Trend assumption: Linear deterministic trend

Lags interval (in first differences): 1 to 1

Unrestricted Co integration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None	0.277886	22.35837	29.79707	0.2790
At most 1	0.179343	10.31218	15.49471	0.2575
At most 2	0.077859	2.999120	3.841466	0.0833

Trace test indicates no cointegration at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None	0.277886	12.04619	21.13162	0.5431
At most 1	0.179343	7.313059	14.26460	0.4528
At most 2	0.077859	2.999120	3.841466	0.0833

Max-eigenvalue test indicates no co integration at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Table B(42)

Co-integration with unrestricted intercepts and with trend of variables included in the Co-integrating vector of productive sector- at 5%.

Series: LN(Q/L) LN(K/L) (LN(K/L))2

Sample (adjusted): 1972 2008
Included observations: 37 after adjustments
Trend assumption: Linear deterministic trend (restricted)

Lags interval (in first differences): 1 to 1

Unrestricted Co integration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None	0.499113	40.86561	42.91525	0.0790
At most 1	0.204221	15.28472	25.87211	0.5509
At most 2	0.168618	6.832655	12.51798	0.3623

Trace test indicates no co integration at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Co integration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None	0.499113	25.58088	25.82321	0.0538
At most 1	0.204221	8.452069	19.38704	0.7793
At most 2	0.168618	6.832655	12.51798	0.3623

Max-eigenvalue test indicates no co integration at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Table B(43)

Co-integration with unrestricted intercepts and no trend of variables included in the Co-integrating vector of productive sector- at 10%.

Series: LN(Q/L) LN(K/L) (LN(K/L))2

Sample (adjusted): 1972 2008
Included observations: 37 after adjustments
Trend assumption: Linear deterministic trend

Lags interval (in first differences): 1 to 1

Unrestricted Co integration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.1 Critical Value	Prob.**
None	0.277886	22.35837	27.06695	0.2790
At most 1	0.179343	10.31218	13.42878	0.2575
At most 2 *	0.077859	2.999120	2.705545	0.0833

Trace test indicates no co integration at the 0.1 level
* denotes rejection of the hypothesis at the 0.1 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Co integration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.1 Critical Value	Prob.**
None	0.277886	12.04619	18.89282	0.5431
At most 1	0.179343	7.313059	12.29652	0.4528
At most 2 *	0.077859	2.999120	2.705545	0.0833

Max-eigenvalue test indicates no co integration at the 0.1 level
* denotes rejection of the hypothesis at the 0.1 level
**MacKinnon-Haug-Michelis (1999) p-values

Table B(44)

Co-integration with unrestricted intercepts and with trend of variables included in the Co-integrating vector of productive sector- at 10%.

Series: LN(Q/L) LN(K/L) (LN(K/L))2

Sample (adjusted): 1972 2008
Included observations: 37 after adjustments
Trend assumption: Linear deterministic trend (restricted)

Lags interval (in first differences): 1 to 1

Unrestricted Co integration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.1 Critical Value	Prob.**
None *	0.499113	40.86561	39.75526	0.0790
At most 1	0.204221	15.28472	23.34234	0.5509
At most 2	0.168618	6.832655	10.66637	0.3623

Trace test indicates 1 co integrating eqn(s) at the 0.1 level
* denotes rejection of the hypothesis at the 0.1 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Co integration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.1 Critical Value	Prob.**
None *	0.499113	25.58088	23.44089	0.0538
At most 1	0.204221	8.452069	17.23410	0.7793
At most 2	0.168618	6.832655	10.66637	0.3623

Max-eigenvalue test indicates 1 co integrating eqn(s) at the 0.1 level
* denotes rejection of the hypothesis at the 0.1 level
**MacKinnon-Haug-Michelis (1999) p-values

Table B(45)

Co-integration with unrestricted intercepts and no trend of variables included in the Co-integrating vector of productive sector- at 5%.

LN(Q/L) LN(K/L)

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Date: 07/14/10   Time: 18:40
Sample (adjusted): 1972 2008
Included observations: 37 after adjustments
Trend assumption: Linear deterministic trend
Series: QL KL
Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)
==========================================================================
Hypothesized                    Trace           0.05
No. of CE(s)    Eigenvalue      Statistic       Critical Value    Prob.**
==========================================================================
None             0.266903        14.41896        15.49471          0.0721
At most 1        0.076167        2.931288        3.841466          0.0869
==========================================================================
 Trace test indicates no cointegration at the 0.05 level
 * denotes rejection of the hypothesis at the 0.05 level
 **MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)
==========================================================================
Hypothesized                    Max-Eigen       0.05
No. of CE(s)    Eigenvalue      Statistic       Critical Value    Prob.**
==========================================================================
None             0.266903        11.48767        14.26460          0.1314
At most 1        0.076167        2.931288        3.841466          0.0869
==========================================================================
 Max-eigenvalue test indicates no cointegration at the 0.05 level
 * denotes rejection of the hypothesis at the 0.05 level
 **MacKinnon-Haug-Michelis (1999) p-values

==========================================================================
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Table B(46)

Co-integration with unrestricted intercepts and with trend of variables included in the Co-integrating vector of productive sector- at 5%.

LN(Q/L) LN(K/L)
Date: 07/14/10 Time: 18:40
Sample (adjusted): 1972 2008
Included observations: 37 after adjustments
Trend assumption: Linear deterministic trend (restricted)
Series: QL KL
Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None	0.321164	19.03596	25.87211	0.2787
At most 1	0.119364	4.703085	12.51798	0.6394

Trace test indicates no cointegration at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None	0.321164	14.33288	19.38704	0.2326
At most 1	0.119364	4.703085	12.51798	0.6394

Max-eigenvalue test indicates no cointegration at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Table B(47)

Co-integration with unrestricted intercepts and no trend of variables included in the Co-integrating vector of productive sector- at 10%.

LN(Q/L) LN(K/L)
Date: 07/14/10 Time: 18:41
Sample (adjusted): 1972 2008
Included observations: 37 after adjustments
Trend assumption: Linear deterministic trend
Series: QL KL
Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.1 Critical Value	Prob.**
None *	0.266903	14.41896	13.42878	0.0721
At most 1 *	0.076167	2.931288	2.705545	0.0869

Trace test indicates 2 cointegrating eqn(s) at the 0.1 level
* denotes rejection of the hypothesis at the 0.1 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.1 Critical Value	Prob.**
None	0.266903	11.48767	12.29652	0.1314
At most 1 *	0.076167	2.931288	2.705545	0.0869

Max-eigenvalue test indicates no cointegration at the 0.1 level
* denotes rejection of the hypothesis at the 0.1 level
**MacKinnon-Haug-Michelis (1999) p-values