The University of Leicester

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"A Study of the Impact of The Egyptian Petroleum Sector on The Egyptian Economy 1962 - 1982"

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Submitted

By

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Dedication

To those who always give not take,
And do so willingly,
To my mother and my father both,
For what they've done for me.

To my sisters and my brothers who,
I much appreciate,
To my wife who has my fondest love,
This work I dedicate.

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ABSTRACT

The main objective of this thesis is to estimate and evaluate the impact of the Egyptian petroleum sector on the Egyptian economy during the period 1962-1982 within both micro and macro-economic approaches.

On the basis of the empirical findings of the study, the oil sector comes out fairly well as a good leading sector in the Egyptian economy. The study has also revealed that the domestic consumption of oil has dramatically increased at a high rate of growth as well as the oil production/reserves ratio is relatively high in Egypt comparing to a country which has a huge amount of oil reserves.

Considering the above three facts, Egypt can face the following problems: 1)The uncertainty of oil discovery and 2) The gains in the terms of trade are limited due to the decrease or the slight increase in oil prices. In this case, it can be anticipated not only the impact of the oil sector to fall but also Egypt can be expected to be a net oil importer in the very near future. Therefore, the study has investigated both oil demand and oil supply sides in Egypt in order to determine the main factors which affect them and which in turn affect the role of the oil sector in the economy in an attempt to reach some policy

recommendations which might help policy makers in planning and controlling petroleum activities in Egypt in such a way that their contributions can be maximized. On the basis of such investigation, it has been concluded that reconsidering the domestic pricing policy of oil in Egypt is very crucial in order to decrease and rationalize domestic oil consumption in particular the analysis of the subsidy system of petroleum products in Egypt has revealed that the system has not achieved its main goals.

Examining the main determinants of oil supply in Egypt, it seems very important to intensify investment in oil exploration activities in order to secure and increase oil reserves and which in turn lead to secure oil supply. Also, it seems reasonable that the relatively optimal policy of oil production in a country at a stage of rebuilding and developing her economy such as Egypt is that policy which produces on a level sufficient to be exchanged for a financial resource and which in turn could be invested in capital formation and thus developing the basic productive sectors. Such policy is thus taking account of future generations by directing oil revenues to future welfare through investment channels.

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Chapter (1)

INTRODUCTION

The decade of the 1970s has produced important economic changes in the Egyptian economy as a result of the economic liberalization policy and the "open door" posture; and the oil revolution resulting in oil price increases. The expansion of oil production in Egypt, in conjunction with the rapid increases in the world oil price throughout the 1970s, has led the petroleum sector to make a substantial contribution to the Egyptian Economy.

(1/1) The Objective of the Study:

The main objective of this study is to evaluate the effects of the petroleum sector on economic development process in Egypt during the period 1962-1982 within both micro and macroeconomic approaches. This main objective is to be considered in terms of the following specific objectives:

(1) to highlight the main features of the petroleum sector in the Egyptian economy over the period of the study;
(2) to examine the inter-industry linkages between the petroleum industry and the other sectors of the Egyptian economy;

(3) to evaluate the multiplier impact of the growth in demand for the output of the petroleum sector on the economy through income multiplier;

(4) to evaluate the impact of the petroleum sector's exports on gross domestic product and its components;

(5) to investigate the correlation between the rates of growth of the petroleum sector's value added on one hand and the rates of growth of value added of other sectors and non-oil gross domestic product on the other hand.

(6) to examine the main factors affecting the performance of the petroleum sector in order to suggest some policy implications which may be useful in guiding policy makers in planning and controlling petroleum sector in such a way that its contribution to the economy could be maximized. Therefore, a study of the demand and supply sides of the petroleum sector has been carried out.

(1/2) The Hypotheses:

There has been a number of hypotheses developed by economists on the significance or insignificance of the contribution of primary exports to economic development of developing countries[1]. These hypotheses, however, are often too general to be used as a basis upon which formulation of economic policies can be made.

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[1] These hypotheses are presented and explained in detail in Chapter (2).

Accordingly , the validity or the relevance of any argument or hypothesis about the impact of the primary export sector on the economic development of developing countries can be better understood if more empirical research on this area is carried out. Such empirical research may also provide a basis for solving the problem of how to achieve more or maximize the impact of the primary export sector on the domestic economy.

This study is undertaken, therefore, to test the following hypotheses:

(1) There are relatively strong inter-industry linkages of the petroleum sector with the other domestic sectors of the Egyptian economy.

(2) There are significant multiplier effects generated by the increase in demand for the output of the petroleum sector on household income (micro-approach).

(3) There is significant impact of the petroleum sector's exports on gross domestic product and its components in contrast to that of the non-oil exports (macro-approach).

(4) There is correlation between the rates of growth of value added in the petroleum sector on one hand and the rates of growth of value added in the other sectors and non-oil gross domestic product on the other hand.

(1/3) The Methodology and Organization of the Study:

In order to achieve the main objectives of the research and test its hypotheses, the study is carried out using three main approaches:

(1) The Descriptive Approach:

This approach is used to investigate the main features and the historical development of the Egyptian petroleum industry, in order to provide relevant background information and historical prospect of this industry within the Egyptian economy. Since the main purpose of the study is to examine the impact of the petroleum sector on the economy, this approach is also used to investigate the main features and economic changes taken place in the Egyptian economy before and after 1973.

(2) The Input-Output Approach:

This approach is used to estimate and analyse the inter-industry linkages of the petroleum sector with the rest of the economy, and also to estimate the impact multipliers generated by the growth in the demand for the petroleum sector's output on the economy through income multipliers.

(3) The Statistical Approach:

This approach is used to estimate and analyse the impact of the petroleum sector's export on macro-economic aggregates i.e. national income and its components. In order to do so, and to shed more light on the mechanism of the economy, a moderate sized and disaggregated macro-econometric model of the type proposed by Klein[2] for the developing economies, is designed for the Egyptian economy.

The correlation technique is used to determine the degree of association between the rates of growth of value added in the petroleum sector on one hand and the rates of growth of value added in the other sector and non-oil gross domestic product on the other hand.

This approach is also used to analyse and examine the main factors affecting the performance of the petroleum sector in the Egyptian economy, in order to reach to some policy recommendations which may be useful in guiding policy makers in planning and controlling the petroleum sector in such a way that its contribution to the economy could be maximized. For this purpose, oil demand and oil supply models are developed[3] in order to determine the main factors affect the demand and supply sides of the petroleum sector in Egypt and which in turn affect its role in the economy.

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[2] This model is explained and examined in detail in Chapter (6).

[3] These are analysed and examined in detail in Chapter (7).

(1/3/1) Organization of the Study:

On the basis of the objectives, the hypothesis and the methodology of the study, the study is divided and organized as follows:

Chapter (2) deals with the theoretical background of the study in order to examine the oil sector from the theory point of view. Accordingly, this chapter is an examination of the economic theories which addressed the role that can be played by the primary exports in economic development of developing countries, and the unbalanced growth argument, in order to examine to what extent the oil sector is a good leading sector in developing countries.

Therefore, the study in this chapter is divided as follows:

(1) Theories of Trade, Development and Underdevelopment:

(2) The unbalanced growth argument and the leading sector hypothesis:

   (i) Balanced and unbalanced growth thesis,

   (ii) What makes a "good" leading sector.

<u>Chapter (3)</u> is to investigate the main aspects which affect the petroleum industry in addition to its different developments.

Therefore, this chapter is divided as follows:

(1) The historical development of the industry.
(2) The structure of the industry and its legal framework.
(3) Resources and Production:
- exploration and reserves,
- production and its development,
- The development of refining capacity.
(4) The domestic consumption of oil products and its developments.
(5) The infrastructure of the industry.
(6) Oil foreign trade and crude oil pricing policy.

<u>Chapter (4)</u> presents the first step in estimating the impact of the Egyptian petroleum industry on the Egyptian economy by examining its direct contribution to foreign exchange earnings;to the balance of payments; to investment and to public revenue.

Since the main concern is to examine the impact of the petroleum sector on the economy, this chapter starts by highlighting briefly the main features of the Egyptian economy and the main changes taken place before and after 1973 in the economy.

Therefore, this chapter is divided as follows:

(1) The Egyptian economy since 1952:
- Before 1973,
- After 1973
(2) The direct contribution to foreign exchange earnings.
(3) The direct contribution to balance of payments.
(4) The direct contribution to investment.
(5) The direct contribution to public revenue.

<u>Chapter (5)</u> deals with the application of the input-output model to estimate and evaluate two main effects, first, the inter-industry linkages of the petroleum sector with the rest of the economy, and secondly the economic multipliers generated by the growth in the final demand for the output of the oil sector. However, before assessing these two effects, the input-output tables are first used to examine the major changes which have taken place in the Egyptian economy.

Therefore, this chapter is divided as follows:

(1) The input-output analysis and the open static input-output model.

(2) The linkage effects.

(3) The multiplier effects.

<u>Chapter (6)</u> is a study of the impact of the petroleum sector on macro-economic aggregates. Since the input-output approach contains specific industry groups with particular production function, while the macro-economic approach provides a complementary method since it enables a statistical test to be made of the impact of a particular sector on the rest of the economy, the study in this chapter, therefore, aims at estimating and assessing the impact of the petroleum sector on the Egyptian economy using the macro-econometric model. It is mainly to estimate the impact of the petroleum sector's exports on gross domestic product and its components during

1962-1981. The related correlation analysis is also presented in this chapter.

Therefore, this chapter is divided as follows:

(1) Specification of the model and formulation experiments.
(2) Estimation of the model and sources of the data.
(3) Testing of the model.
 - Testing for the direction of causality.
(4) The derivation of the impact multipliers.
(5) Correlation analysis.

<u>Chapter (7)</u> is an investigation of oil demand and oil supply in Egypt in order to examine to what extent these both sides affect the role of the oil sector in the Egyptian economy and then reach to some policy implications which may help policy makers in planning and controlling the petroleum sector in such a way that its impact could be maximized.

Therefore, the study in this chapter is divided as follows:

(1) The demand side:
 - Domestic pricing of oil and the system of subsidy in Egypt,
 - Specification of the demand model for petroleum products,
 - Data sources and their implementation,
 - Estimation procedure and estimation of the models,
 - The price and income elasticities,
 - Models simulation and policy simulation.

(2) The supply side:
 - Oil reserves,
 - Depletion policy,
 - Government policy.

Finally,

Chapter (8) gives the conclusion and policy implications of the main findings of the study.

Chapter (2)
The Oil Sector &
The Theory Point of View

(2/1) Introduction:

Since the oil sector depends in a high percentage on foreign trade, and in order to examine its impact on the Egyptian economy, the theoretical background has depended mainly on two main grounds: First, on the economic theory which addressed the role that can be played by the primary exports in promoting economic development of developing countries, and secondly, the unbalanced growth argument, in order to examine to what extent the oil sector is a good leading sector in developing countries.

Therefore, the present chapter aims at examining the existing theories of trade, growth and development, and highlighting the major developments in the literature in order to examine their applicability to developing countries. Having examined these theories and their applicability to developing economies, the study turns into the question to what extent is the oil sector a "good" leading sector in developing countries. The study, then, has been divided into two main sections as follows:

First: the theories of trade, development & underdevelopment:

Second: unbalanced growth argument and then leading sector hypothesis has been examined.

(2/2) Theories of Trade, Development & Underdevelopment:

The investigation of the existing theories of trade, growth and development can reveal that there are two main schools of economic thought regarding the contribution of the primary export sector to the economic development of developing countries. The first school basically composes of the trade theory economists and the staple theory economists. The trade theory economists, in particular classical economists believe that international trade is an engine of growth for the following reasons:[1] Firstly, through the benefit postulated in the "vent for surplus" theory. International trade overcomes the narrowness of the domestic market and provides an outlet for the surplus product above domestic requirements. Secondly, by widening the extent of the market, foreign trade also improves the division of labour and raises the general level of

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[1]For a good survey of the classical theory of international trade, See: C.P. Kindleberger, International Economics, (Richard D. Irwin, INC., USA, 1968(, Part 1: A. K. Dixit & V. Norman, Theory of International Trade, (Cambridge University Press, London, 1982).
- H. Myint, The Classical Theory of International Trade & The Underdeveloped Countries, (Economic Journal, 1958), pp. 317-37;
- G. Haberler, International Trade & Economic Development, Mr J.D. Theberge (ed), Economics of Trade & Development, (John Wiley & Sons, Inc., New York, 1968), pp.103-112;
- R. Nurkse, Patterns of Trade & Development, Mr J.D. Theberge, (ed.), Economies of Trade & Development, op.cit, pp.85-102.

productivity within the country. Thirdly trade will enable the teaching countries to reallocate their given resources more efficiently between domestic and export production in the light of comparative advantage.

The staple theory economists [2] also argue that the export of primary products has a direct contribution to the rest of the economy. As the demand for the staple export product increases, the quantity supplied also increases, thus, resulting in an increase in income by spending this income, investment opportunities in the other sectors of the economy would be generated.

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[2]See: R.E. Caves & R.H. Holton, The Canadian Economy: Prospect & Retrospect, (Cambridge, Mass., 1959);

- M.H. Watkins, A Staple Theory of Economic Growth, The Canadian Journal of Economics & Political Science, May 1963), pp.141-158;

- H. Innis, Essays In Canadian Economic History, ed. by M.A. Innis, (University of Toronto Press, 1956), pp.3-16.

- K. Buckley, The Role of Staple Industries In Canada's Economic Development, (Journal of Economic History, Dec. 1958), pp.442-5.

The second school which is composed of Singer-Myrdal-Prebisch arguments[3] and dependency theory economists, considers international trade as having a negative effect on economic development of developing countries. Their view stems from the nature of the exports of developing countries, i.e. primary products. Each economist seems to emphasise a different cause.

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[3]H.W. Singer, The Distribution of Gains Between Investing & Borrowing Countries,(American Economic Review, May 1950), and reprinted in J.D. Theberge, Economics of Trade & Development, op. cit., pp.236-248.

- H.W. Singer, The Distribution of Gains from Trade & Investment - Revisited. (Journal of Development Studies, vol. 11 Jan. 1975), p.377;

- G. Myrdal, Economic Theory & Under-Developed Regions, (Gerald Duck Worth & Co. LTD., London, 1957), pp.23-35;

- R. Prebisch, Development Problems of the Peripheral Countries and the Terms of Trade, In J.D. Theberge, Economics of Trade & Development, op. cit., pp.287-97; R. Prebisch, Commerical Policy In The Underdeveloped Countries, (American Economic Review, May 1959), pp.251-73, also M.J. Flanders, Prebisch on Protectionism: An Evaluation, In. J.D. Theberge, Economics of Trade & Development, op. cit., pp.298-322;

- P.T. Bauer, International Economic Development, (Economic Journal, vol.69, 1959), pp.105-123;

- G. Meier, The International Economics of Development, Theory & Policy, (Harper & Row, New York, 1968), pp.245-6, also G. Meier, International Trade & International Inequality, In J.D. Theberge, Economics of Trade & Development, op. cit., pp.249-261;

- J.R. Hicks, Essays In World Economics, (Oxford University Press, London, 1959), ch.8.

A summary of the main causes includes:- 1) the world environment in which the terms of trade are believed to turn systematically against the developing countries,2) the domestic impediments in developing countries such as factor immobility, price rigidity, narrow domestic market,..etc., 3) primary export sector is an enclave sector financed by foreign capital and located in developing countries only in a geographical sense while economically part of the investing country, 4) dependency theory economists * see the relations between developed and underdeveloped countries as a chain of exploitation in which the economies of developing countries were forced into a position of complementarity with those of developed countries. Since developed countries aimed at searching for new sources of raw materials, new markets for manufactures, and for new sources of labour to exploit, and as a result of the concentration on primary production for the world market, developing countries have been prevented from industrializing.

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*G. Frank, The Development of Underdevelopment, (Monthly Review, vol. XV11 No.4, Sep. 1966), pp.17-30;
- J.T. Thoburn, Primary Commodity Exports & Economic Development, (John Wiley & Sons, London 1977), pp.35-8;
- M. Barratt Brown, The Economics of Imperialism, (Penguin, London, 1974);
- P.J. O'Brien, A Critique of Latin American Theories of Dependency, In 1. Oxaal, T. Barnell, & D. Booth, Beyond The Sociology of Development, (Routledge & Kegan Paul, London, 1975), p.19;
- Dos Santos, The Crisis of Development Theory and the Problem of Dependence in Latin America, In. H. Bernstein (ed.), Underdevelopment and Development: The Third World Theory, (Penguin, London, 1976), p.72.

(2/3) The Oil Sector & The Leading Sector Hypothesis:

The idea that economic development should proceed with leading sectors or "growing points" of the economy is put forward in the unbalanced growth theory. Whether or not the unbalanced growth strategy is the most suitable for less developed countries to adopt in order to achieve faster growth is a matter of dispute among development economists and a dichotomy has developed between the balanced and unbalanced growth proponents. This debate is inevitably involved in an answer to the question of whether the oil industry is a "good" leading sector because one is forced to consider whether it is correct to adopt a leading sector strategy. The main subject, then, is to discuss whether, by the criteria of the proponents of leading sector development, the oil sector can produce the desired effects of faster growth and capital formation. In order to do this, it is necessary to explain something of the theory which promotes leading sector development and its contradictory, and thereafter examine what makes a "good" leading sector and then assess to what extent the oil sector meets those requirements according to theory measurement.

(2/3/1) Balanced and Unbalanced Growth Thesis:

The general argument of underdevelopment is that underdeveloped countries are held back by a chain of interlocking "vicious circles". It has seemed to many economists that the only way to break these vicious circles is to undertake a concerted programme of industrial and agricultural investment. There have been many important issues of development policy to explain the transition from underdevelopment to development. Balanced and unbalanced growth are both seen as ways of achieving this.

The term "balanced growth" is used in many different senses but the original exponents of the doctrine had in mind "the scale of investment necessary to overcome indivisibilities of both the supply and demand sides of the development process."[5] On the supply side, the development of manufacturing industry first requires heavy investment in social overhead capital. This investment is indivisible, its minimum size is very large and takes considerable lengths of time to bear fruit. Therefore to make this investment worthwhile, there must be a simultaneous development of producer and consumer goods industries so that initial excess capacity is quickly utilized.

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5 P.N. Rosenstein - Rodan, Problems of Industrialization of Eastern and South-Eastern Europe (Economic Journal, 1943), pp.204-7.

On the demand side, it is argued that "if enough projects are started simultaneously, they will generate sufficient income in the economy as a whole and then provide demand for one another's output and this create inducement for further investment".[6]

Balanced growth has also been treated as "a means of achieving greater diversification in the underdeveloped countries, which is considered to be essential in view of the growing barriers to international trade and particularly the resistance encountered by the exports of the developing countries".[7]

Summing up, balanced growth can be said to mean the path of development and the pattern of investment necessary to keep the different sectors of the economy in balanced growth in relation with each other, with particularly emphasis on the intersectoral balance between industrial and agricultural.

In contrast, unbalanced growth is generally taken to mean "a pattern of growth in which some sector of the economy are advanced ahead of others."[8] Although allowance can be made for this in the balanced growth

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6 R. Nurkse, The Conflict Between Balanced Growth & International Specialization, In His Equilibrium & Growth In The World Economy , op. cit., p.249.

7 T. Scitovsky, Growth-Balanced or Unbalanced, In M. Abramovitz & Others, (ed.), The Allocation of Economic Resources, (Stanford University Press, California, 1959), p.210.

8 A. Mathur, Balanced V. Unbalanced Growth - A Reconciliation View, (Oxford Economic Papers, 1966), pp.141-2.

theory, the distinguishing feature is the rapidity of advance of certain sectors which is accommodated by resultant imbalances in the form of excess capacity in some sectors (normally the leading sectors) and shortages in other sectors. Shortages are thus assigned importance by virtue of the investment that they induce. [9]

The unbalanced growth thesis thus suggests that resources should be concentrated into sectors inevitably leads to shortages and bottlenecks along the line. Instead of retarding growth (as the balanced growth theory suggests), shortages are seen as beneficial because they evoke reliance on the inducement mechanism and promote decision making ability-assumed to be a scarce resource in less developed countries. When a shortage in supply exists the price is raised, hence the profitability of production in that line is increased and it becomes more attractive to entrepreneurs. Looked at another way the necessity caused by shortages and disruptions to the production process increase the incentive to improve the situation. An often cited example is that of the British textile industry during the industrial revolution. Shortages of yarn and weaving capacity led to a chain of innovations which revolutionized textile manufacture and increased output many times.

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9 A. Mathur, Balanced V. Unbalanced Growth - A Reconciliation View, op. cit., p.142, T. Scitovsky, Growth - Balanced or Unbalanced, op. cit., p.216.

At one time, balanced growth (BG) and unbalanced growth (UG) were seen as mutually exclusive and polar development strategy, but recent discussion has emphasised that the differences between the two strategies have been overstated. In particular, A. Mathur argues that the problem of overcoming supply indivisibilities and the need for a "Big Push" inherent in the BG doctrine is just as applicable to the UG argument. The essential difference according to Mathur is the role of shortage. [10]

BG theorists argue that shortages retard growth on the ground that output of final goods cannot expand as fast as it could if the supply of all inputs were readily available, UG theorists consider them as beneficial inducements which minimize the use of that "scarce factor", the decision-taking ability. However, Mathur argues that the nature of shortages can vary and may be full or semi-growth promoting or frustrating. If shortages are due to the introduction of technology enabling a certain stage or stages to increase output, which cause bottlenecks in the production process, there will be a clear inducement to increase investment in invention and innovation. This is a kind of challenge - and - response situation. When such shortages give rise to innovation and increased output, they are referred to as growth promoting shortages. However, where shortages are caused by a lack of factors of

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10 A. Mathur, Balanced V. Unbalanced Growth - A Reconciliation View , op. cit., pp.143-57.

production, growth may or may not be growth promoting shortages. This depends on the ability of market mechanism to eliminate imbalances in the long run. For example, if there is a car industry set up in a less developed country and at first, there is no tyre manufacturing industry, there would be a strong market inducement to set up such tyre industry, and may be undertaken directly by entrepreneurs. In the long run the shortage would be almost eliminated and this be called "semi-growth promoting shortages. However, if a bicycle manufacturing industry is set up and there is no steel industry to supply the basic raw materials, then it is unlikely that the demand for steel will be sufficient to set up a steel industry, due to the necessity for large scale production. This would be called a "semi-growth frustrating shortage". Mathur points out that these shortages would be likely to occur in the absence of SOC (Social Overhead Capital) where investment must initially be very large.

The importance of this distinction between types of shortages is clear. Where shortages generated by a strategy of UG are semi-growth frustrating then that strategy will inevitably encounter problems. In such cases, there is a need for the state to intervene by investing in SOC, such that growth is not held back indefinitely. Thus the basic contention of the BG doctrine that over-all development should not be retarded by the unbalanced growth of demand and supply in all sectors, does not in any way clash with the principle of UG, and as Mathur concludes, given the limited availability of resources facing most developing countries, a strategy of balance within imbalance could be adopted-within an unbalanced pattern of growth, steps could be taken to ensure that the supply of each input matches the demand for it as it arises. Hence UG can be viewed as a scaled down version of the BG strategy.

(2/3/2) What Makes a "Good" Leading Sector:

On the basis of UG strategy, the question now is what makes a "good" leading sector and to what extent does the oil sector meet these requirements. T. Scitovsky has identified two arguments:[11] The traditional argument which is intuitively sensible from the theory and consistent with the theory of comparative advantage. According to this argument countries should choose leading sectors for which comparative advantages exist. Thus leading sectors should include those with favourable resource combinations, specialised skills, raw materials, climatic advantages and newly discovered productivity enhancing techniques..etc., and the modern argument which focuses attention on advantages of large scale production and economies of scale arising from growth by large steps. By this reasoning, the best leading sectors are those where

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[11] T. Scitovsky, Growth -Balanced or Unbalanced? , op. cit., pp.207-17.

the optimum scale of production is large. Concentration of resources in these areas would in theory enable less developed countries to compete with other producers.

On the basis of comparative advantage and economies of scale, the oil sector comes out fairly well as a leading sector on both accounts. In developing countries there is a comparative advantage in producing oil simply because of its existence in some countries and not in others. As a raw material for industries using oil as an input it is also a source of comparative advantage. However, the extent of comparative advantages varies from country to country.

On the economies of scale criteria, oil should once again come out well since the optimal scale of production is relatively large and similarly in industries that use oil as a raw material. Thus, oil comes out well as a leading sector by the criteria used so far.

The most robust method of assessing leading sectors is to examine the linkages between the sector and the rest of the economy. The linkage framework was developed initially by Albert Hirschmann and is based on the argument for unbalanced growth outlined above. Hirschmann suggests that investment is induced as a result of concentration on a leading sector by two mechanisms: [12] First, a non primary activity employing significant amounts of intermediate

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[12] Albert Hirschmann, The Strategy of Economic Development, (New Haven: Yale University Press, 1958), pp.98-116.

inputs from other activities induces attempts to supply inputs through expanding domestic production. This is the "backward linkage" effect. Second, a non final activity that does not cater exclusively to final demand induces attempts to utilise its outputs as inputs in some new activities. This is the "forward linkage" effect. On the basis of this it is possible to draw up a ranking of priorities as follows: The first and last priority are assigned the sectors that have high-backward-high-forward, and low-backward-low-forward linkages, respectively. Second and third priority are assigned the sectors that have, respectively, high-backward-low-forward, and low-backward-high-forward linkages.

The next step is to assess whether oil is in fact a "good" leading sector by this criterion. In order to do so, we can measure forward and backward linkages and derive a linkage coefficient of oil sectors in various countries with the use of input/output data and using the following formulas:

Backward linkage for any j^{th} sector (LB_j) is defined as the ratio of purchased intermediate input to the total value of production,

(1) $$LB_j = \frac{\sum_i X_{ij}}{X_j} = \sum_i a_{ij}$$

where:

X_{ij} represents the number of units of commodity i used in production of X_j units of commodity j. Correspondingly, forward linkage for any i^{th} sector (LF_i) is defined as the ratio of interindustry demand to total demand,

$$(2) \qquad LF_i = \frac{\sum_j X_{ij}}{Z_i},$$

where:

Z_i is the sum of interindustry ($\sum_j X_{ij}$) and final (Y_i) demand for commodity i. Backward and forward linkages are direct effects.

A total linkage index should also consider the indirect effects that emanate from the direct linkage effect. Thus total linkage for the j^{th} sector (LT_j) is defined as the effect of both direct and indirect linkages,

$$(3) \qquad LT_j = \sum_i a^*_{ij},$$

where: $\qquad a^*_{ij} = (I - a_{ij})^{-1}$

Empirical work on measuring backward and forward linkages has produced broadly similar results in the case of oil. For instance, Watanabe and Chenery have calculated a forward coefficient of 0.97 which is very high and backward linkage of 0.15 which is low (for petroleum and natural gas in the US, Japan, Italy and Norway).[13]

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13 H.B. Chenery and T. Watanabe, International Comparisons of The Structure of Production, (Econometrica, Oct. 1958), pp.487-521.

On the basis of these measurements which show low-backward and high-forward linkages in economies where oil sectors exist, the oil industry would appear to be an averagely good leading sector.

It is very important to bear in mind however, that comparisons of this sort are highly problematical. In the first place data on inputs and outputs are often not readily available in many of developing countries. Secondly, cross sectional data of this kind may be misleading and it would possibly be more revealing if time series data were used since this would show the development of linkages over time. Finally, and most importantly, this may be a poor comparison in the sense that it concentrates mainly on oil sectors in developed countries whose more developed infrastructures and higher level of economic activity are bound to produce a higher linkage coefficient than developing countries.

One can however, use these results to say that these are the kind of linkage coefficients that can be expected as a result of using oil as a leading sector for development.

In conclusion, examining the unbalanced growth argument and thus the leading sector hypothesis and the criterion which makes a good leading sector (i.e. comparative advantage, economies of scale and linkages criterion), the oil sector comes out fairly well as a good leading sector in economic development. However in the case of Egypt, whether it is true or not that the oil sector has a positive impact on the Egyptian economy and comes out fairly well as a good leading sector, is a matter for empirical investigation which represents the main concern of the empirical work in the next chapters.

Chapter (3)

The Main Features of The Egyptian Petroleum Industry

(3/1) Introduction:

For more understanding of the Egyptian Petroleum industry and its impact on the Egyptian economy, a useful starting point is to examine the main aspects which affect the industry in addition to its different developments. Therefore, the present chapter deals mainly with the historical development of the industry; the structure of the industry and the legislations which affect its activities; its resources and production; the domestic consumption of petroleum products and its development; the industry's infrastructure and its development; and finally oil foreign trade and crude oil pricing and price developments.

Accordingly, the present chapter has been divided into six main sections as follows:

1. Historical development of the Egyptian petroleum industry;
2. The structure of the industry and the legal framework;
3. Resources and production:
   - explorations and reserves,
   - production and its development
   - the development of refining capacities

4. Domestic consumption of oil products and its developments.
5. The infrastructure of the industry.
6. Oil foreign trade and crude oil pricing policy.

(3/2) The Historical Development of the Egyptian Petroleum Industry:

The historical discovery of oil in Egypt dates from ancient times when oil was recovered from seepages at Gebel El-Zeit by the Pharaohs along the south Western side of the Suez Gulf. However the transferring point of the Egyptian petroleum industry started by the first economic discovery in Gemsa in 1905 developing the first oilfield in Egypt. Its production however started in 1910 by the Red Sea Oil company which was a member in Shell company group and became the Anglo Egyptian oil company afterward.

For more understanding of the historical development of the Egyptian oil industry, it might be better to divide the historical period from 1910 up to now as follows:

(1) 1910-1952:

During this period, it can be argued that the Egyptian oil industry and its activities were entirely dominated by the foreign companies in particular the British ones. The Anglo Egyptian oil company was dominating completely exploration and production activities and owning 88% of the country's total refining capacity.

It was also dominating the domestic marketing activity since its share of this activity was about 98%, although some American oil companies were sharing it.[1]

In 1948, the law of mines and quarries No.136 was issued to be the first legislation of organizing searching for and exploiting minerals including petroleum. However, on the other hand, this law led the existing foreign oil companies to refuse any more searching for oil in Egypt since the concessions according to this law were only granted to the Egyptians.

(2) 1952-1959:

In the wake of 1952 revolution, the economic role of the state started to increase and the wave of nationalization started to affect the petroleum industry. However, because of the technical and financial difficulties of the national companies and to open the door for foreign oil companies the law No.66 of 1953 was issued to cancel the law No. 136 of 1948 and which was amended by the law No.86 of 1956. As a result the state concentrated on national companies to search for oil and diversifying its dependence on foreign oil companies by entering into agreements with the independent American oil companies in 1954. In 1957 the General company for Petroleum was formed entirely with national capital. In 1958 the state entered

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[1] EGPC, The Introduction to the Petroleum Industry, (Cairo, 1983), p.95.

into co-operation agreement with Soviet Union for exploring oil. As a result of this policy the number of commercial discoveries increased and which in turn led to increase oil reserve from 25 million cubic meter to 58 million cubic meter within this period.[2]

(3) 1960-1972:

This period could be called the liberalization, planning and development period. During this period the role of the public sector considerably increased and the Anglo Egyptian Company was nationalized completely by 1964. Also the General Authority for petroleum was formed (and which became the EGPC afterward) to own and manage complete stages of the industry namely refining, transportation and marketing. This was in addition to sharing the exploration responsibilities with foreign capital in areas which do not need high expenditure and have a good chance of finding commercial quantities of oil. In spite of the expansion of the public sector's role in oil industry as a reflection of the structural change in the country during this time, the foreign oil companies were still enjoying a share in the industry's operations especially in the marine fields where cost of exploration is high and the probability of finding oil is more uncertain.

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[2] EGPC, Annual Report, (Cairo, 1980), p.4.

During this period, "the exploration agreements with foreign oil companies have changed from the concessions of the pre-1960's to participation agreements, which were subsequently converted into production-sharing agreements. Under the concession arrangements, the government imposed a royalty and tax on the oil companies that did not exceed the companies' net-of-cost realization (computed on the basis of posted price) by more than 50%. In 1963 the government of Egypt for the first time entered into a participation agreement (with Ente Nazional Idrocarburi, an Italian firm) by which the costs of exploration and development were shared equally between the foreign contractor and the national oil company. The profit from oil was also shared equally, with the government reserving the right to tax the foreign contractor to a maximum level of 50% on its share of profit oil".[3] By this device, the government's "take" was increased significantly over the earlier concession agreements.

"In 1970 the government of Egypt entered into the first production sharing agreement. Accordingly, the cost of exploration and development was borne exclusively by the foreign contractor and amortized, interest-free, over the next four and eight years, respectively. After amortization and the operating costs were taken into account, the profit oil was shared between the foreign

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[3] K. Ikram, Egypt, Economic Management In a Period of Transition, (Johns Hopkins University Press, 1980), p.277.

contractor and the government in the ratio of 40:60.[4]

(4) 1972-1983

As a result of the open door policy in 1974 and the high increase in oil prices, the Egyptian petroleum industry has expanded its operations and the number of the oil agreements with the foreign oil companies has highly increased. Accordingly the number of the oil agreements increased from only six agreements until 1973 to 89 agreements in 1983. Egypt oil production increased from 16404 thousands metric tones in 1970 to 35957 metric tones in 1983, the refining capacity also increased from 3371 thousands metric tones in 1970 to 18144 thousands metric tones in 1983; and oil exports increased from 24694 thousands Egyptian pounds in 1973 to 2096113 in 1983.[5] Also Egypt oil reserves increased from 2550 million barrels in 1970 to 4257 million barrels in 1983.[6]

Egypt could also improve upon the agreements' conditions and in some Egypt's share in the profit oil has been negotiated at 87%.[7]

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[4] Ibid, p.277.

[5] EGPC, Annual Report, (Cairo, 1983).

[6] R. Abdin, For Efficient Policies to Developing & Using the Egyptian Energy Resources, (National Planning Institute, Cairo, 1985), p.75.

[7] K. Ikram, Egypt, Economic Management in Period of Transition, op. cit, p. 277.

The Egyptian petroleum sector to achieve its goals as a leading sector in the development process of the whole country, has set up for itself four major targets: a) to satisfy the domestic needs for petroleum products, b) to assure enough petroleum reserves to face increasing future demand, c) to make the petroleum sector one of the main sources of national income, and d) to provide enough foreign exchange needed to acquire capital goods and technology for both petroleum and development activities.

(3/3) The Structure of the Petroleum Industry and Legal Framework:

(3/3/1) The Structure of the Industry:*

As the Annual Report explains, petroleum companies in Egypt are formed in three financial shapes according to its legal formations and the ownership of its capital as follows:

(1) Public Sector Companies:

They carry out executive activities in all aspects of petroleum industry, exploration, production, refinery, transportation and marketing. Every company of such companies is specialized in one activity of the industry following the principle of specific specialization of companies beading at the highest degree of efficiency the best producibility.

The capital of such companies is owned totally to the country represented in EGPC.

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*The information in this section is a summary of part of the Annual Report, EGPC, 1983, pp.14-21

Table (3.1) shows the classification of such companies.

Table (3.1) Public Sector Companies

Production Companies	Refining Companies	Transportation Companies	Marketing Companies
1) General Petroleum Company (GPC)	1) Suez Oil Processing Co 2) Cairo Oil Refining Co 3) El Nasr Oil Co 4) Alexandria Oil Co 5) The Egyptian Petrochemical Co.	1) Pipeline Petroleum Co	1) Petroleum Cooperative Society 2) Misr Petroleum Co 3) Petroleum Gases Co

(2) Joint Companies:

The capital of these companies is shared equally between EGPC and the foreign partner. These companies consist of eleven companies as shown in Table (3.2) which also shows the dominance of the American partners.

(3) Companies Subjugated to Law of Investment of Arab and Foreign Funds, Free Zones or an Establishment Submitted to Special Laws:

These companies can be divided into two groups. The first consists of companies in the form of joint companies their capital is shared between different partners and it is not necessary EGPC one of them as in the previous

Table (3.2) Joint Companies

The Name	The Partners With EGPC
1) Gulf of Suez Petroleum Co	Amoco in the USA
2) Akma Oil	Amoco
3) Tor Sinai Oil	Amoco
4) Rodko	Amoco
5) Western Desert Petroleum Co	Philips Petroleum Co in the USA
6) Belayim Petroleum Co	International Egyptian Oil Co (IEOC) which belongs to an Italian Co
7) Suez Oil Co (SuCo)	Deminex, BP and Shell Wenning
8) Deminex Egypt Oil	Deminex, BP and Shell Wenning
9) Mobil El Nil Oil Co	Mobil Egypt Co
10) AGYBA Petroleum Co	Egypt Co
11) Badr Petroleum Co	Shell Wenning

group. The second group consists of foreign concession companies and which consists of 31 companies by the end of 1983. However this number decreased into 28 companies by 1984 since some of the companies ended their contracts. The two groups of such companies are shown in Table (3.3).

Table (3.3) Companies Subjugated to Law of Investment of Arab and Foreign Funds, Free Zones or an Establishment Submitted to Special Laws

Joint Companies	Foreign Concession Companies
1) The Arab Petroleum Pipelines Co (Sumed)	1) Amoco Oil Co USA
2) Petroleum Projects & Technical Consultation Co (PETROJET)	2) Philips Petroleum Co USA
3) Engineering for the Petroleum and Process Industries (ENNPI)	3) Deminex Co Germany
4) Aereal Services Co	4) Esso Suez Inc Co USA
5) Natural Gas Projects Co	5) Shevron Oil Egypt Co
	6) Quintana Suez Limited Co
	7) Shell Winning Co Dutch
	8) EGEPECTO Gas & Oil Exploration Co
	9) Continental Mid Delta (CONOCO) USA
	10) British Petroleum for Developments Co UK
	11) Union Co USA
	12) Canadian Superior (Ended its contract 1983)
	13) International Egyptian Co (ZEOC) Italy
	14) Total Near East Co France
	15) Egypt ELF Aqitain Co
	16) Gulf Oil Suez Limited Co (ended its contract 1983)
	17) Egypt Mobil Exploration Co
	18) United Egypt Sidco Co
	19) Marathon Petroleum Co
	20) EPEDECO Co
	21) San Joe Co (ended its contract 1983)
	22) Murphy Co
	23) L.L.& I. Swiss Inc
	24) Petrofina Co
	25) Gulfstream Co (ended its contract in 1983
	26) Mediterranean Oil & Gas Limited Co
	27) Gulfoil Shadwan Limited Co
	28) Lochial Exploration Limited Co
	29) Karim Petroleum Development Co
	30) Getty Oil Petroleum Co USA
	31) Feneks Co

(3/3/2) The Legal Framework:

The foundation of any contract for oil operations in Egypt is based on the mines and quarries law No. 86 of 1956 which states that:

1. All minerals including petroleum, existing in mines and quarries in Egypt including the territorial waters, are the property of the state;
2. The minister of petroleum is entitled to enter to concession agreement with EGPC and with other company as a contractor;
3. No one is allowed to search for oil without being granted a concession for searching for and discovering oil;
4. The priority is given first to the Egyptians and the foreign contractors are obliged to have residence for them in Egypt;
5. The government is entitled to buy at most 20% of crude oil produced in the area or of refined products at a price less than market price by 10% or less;
6. The priority of produced oil is given first to domestic refineries to satisfy domestic needs at a price not more than export price.

(3/3/2/1) The Main Terms of the Concession Agreements:

Any oil agreement between the EGPC and the foreign contractor is based on a production sharing system in particular after 1970. The main elements of the production sharing agreements are:

1. Egypt represented by the EGPC does not bear any initial risks or costs of exploration, or any at all if no oil is found;

2. On commercial discovery of oil, an operating company shall be formed to undertake the actual production of oil;

3. The contractor shall bear and pay all the costs and expenses required in carrying out all the operations under the agreement but such costs and expenses shall not include any interest on investment and contractor shall look only to the petroleum to which it is entitled under this agreement to recover such costs and expenses;

4. The contractor shall recover all costs and expenses in respect of all exploration, development and related operations under the agreement to the extent and out of 40% quarterly of all crude oil produced. Such crude oil is referred to as "cost recovery crude oil". Accordingly, all exploration, development and production costs shall be recovered from cost recovery crude oil in the following manner:

a. All operating expenses, incurred and paid after initial commercial production, shall be recoverable either in the tax year in which such costs are incurred and paid or the tax year in which initial commercial production occurs;

b. Exploration costs, including those accumulated prior to the commencement of initial commercial production shall be recoverable at the rate of 20% per annum;

c. Development costs, including those accumulated prior to the commencement of initial commercial production shall be recoverable at the rate of 20% per annum also.;

d. If costs fall below the 20% the difference accrues to the state, and if these costs exceed the value of all cost recovery crude oil, the excess shall be carried forward for recovery in the next succeeding year or years until fully recovered, but in no case after the termination of the agreement as to contractor;

5. The remaining 60% of the crude oil or the profit oil is shared between the foreign contractor and the EGPC in the ratio of (25-13): (75-87) according to the terms of the agreement;

6. The exploration period is one year and it may be renewed for additional period according to the terms of the agreement. However, the government is entitled to not renewing it after the eighth year;

7. The exploitation period is not more than 30 years. However this period may be extended for not more than another five years according to the agreement terms;

8. The government shall own and be entitled to a royalty in cash or in kind of 10% of the total quantity of petroleum produced and saved from the area during the

development period including renewal. Said royalty shall be borne and paid by EGPC and shall not be the obligation of the contractor;

9. The contractor shall be subject to the laws in force in Egypt and the political subdivisions thereof, which impose taxes on or are measured by income or profits;

10. EGPC shall become the owner of all assets acquired and owned by contractor in connection with the operations carried out by contractor or operating company;

11. The contractor shall pay certain amounts of money as bonuses for signature and production. Such amounts differ according to the terms of the agreement;

12. EGPC; contractor, operating company and their contractors and sub-contractors engaged in carrying on operations under the agreement shall be permitted to import and shall be exempted from customs duties with respect to the importation of machinery, equipment, vehicles, materials, spare parts, supplies, consumable items, foodstufffs and movable property when certified by responsible representative of EGPC to be used solely on carrying in operations under the agreements;

13. Relating to employment rights and training:

a. The expatriate employed by the contractor or operating company shall be granted a residence and contractor agrees that all immigration, passport, visa and employment regulations of Egypt shall be applicable to all alien employees of contractor working in Egypt;

b. A minimum of 25% of the combined salaries and wages of each of the expatriate shall be paid in Egyptian currency;

c. The contractor and operating company shall each select its employees and determine the number hereof, to be used for operations hereunder;

d. The contractor shall, after consultation with EGPC, prepare and carry out specialized training programs for all its Egyptian employees engaged in operations hereunder with respect to applicable aspects of the petroleum industry. Contractor and operating company undertake to replace gradually their non-executive expatriate staffs by qualified nationals as they are available.

<u>(3/4) Resources and Production:</u>

This section deals with the geological aspects of petroleum production in Egypt, exploration activity and reserve position of petroleum resources, production and its development and the development of refining capacities.

(3/4/1) Exploration and Reserve Position:

Since the establishment of the Ministry of Petroleum in 1973 and as a result of Egypt's policy which aims at the intensification of the search for new resources of crude oil and natural gas, the previous provinces were covered by a total of 89 exploration agreements in the period 1973-1983. As a result of increasing investment in exploration there were 12 discoveries in 1980, 10 in 1981, 13 in 1982 and 17 in 1983 as shown in table (3.4). From table (3.4) some remarks can be concluded as follows:

1. Because of concentrating exploration activity in the Gulf of Suez, the success in this province has been extensive as well as the number of discoveries were relatively high in it.

Table (3.4) Distribution of Exploratory

Wells During the Period 1980-1983

Area	1980			1981			1982			1983		
	completed drilling	on drilling	discoveries	completed drilling	on drilling	discoveries	completed drilling	on drilling	discoveries	completed drilling	on drilling	discoveries
Offshore Wells												
Gulf of Suez	32	4	9	39	7	15	8	38	7	7	28	8
Northern Sinai	-	-	-	1	-	-	1	2	1	1	2	1
Nile Delta	2	-	-	1	1	1	-	2	-	-	2	1
Total Offshore	34	4	9	41	8	16	9	42	8	8	32	10
Onshore Wells												
Western Desert	5	1	1	5	1	2	1	15	3	5	19	7
Delta	5	1	1	6	1	-	1	2	-	-	2	-
Eastern Desert	-	-	-	-	-	-	-	-	-	-	1	-
East Gulf	3	-	-	4	-	-	1	8	-	2	2	-
West Gulf	7	1	1	6	1	1	2	9	2	1	9	-
Northern Sinai	2	-	-	-	-	-	-	-	-	-	1	-
Total Onshore	22	3	3	21	3	3	5	34	5	8	34	7
Comulative Total	56	7	12	62	11	19	14	76	13	16	66	17

Source: EGPC, Annual Reports 1980, 1981, 1982 and 1983, (Cairo)

2. Although Western Desert province has a very promising hydrocarbon potential, oil companies however, have been reluctant to assume risk and to explore extensively in this province. This reluctance, in itself, has contributed to the pessimistic assessment of this province relative to the other petroliferous provinces in Egypt in particular the Gulf of Suez;

3. It must also be concluded that the few, widely-spaced Wells drilled in northern Sinai are not sufficient for judging its oil potential and this is mainly due to the uneven exploration activities undertaken over the territory of Egypt.

As a result of intensifying the efforts in exploration activities in the oilfield, the proven reserve of oil in Egypt increased about 5.8 times during the period 1960-1969. This reserve still continues to increase until it reached 3325 million barrels in 1982 as shown in Table (3.5).

<u>(3/4/2) Crude Oil Production:</u>

Crude oil production in 1983 reached a record of about 36 million tonnes i.e 4.8 times the figure of 1974 of 7.5 million tonnes and an increase of 9.3% over 1982 as shown in Table (3.6) which shows the growth of crude oil production according to the production Zone in Egypt since 1970-1983.

Table (3.5) Proven

Oil Reserve 1960-1982*

Years	Proven Reserve (million Barrels)
1960	540
1961	700
1962	710
1963	1500
1964	1500
1965	2000
1966	1450
1967	1400
1968	2170
1969	3050
1970	2550
1971	2050
1972	3250
1973	3150
1974	1750
1975	1930
1976	1950
1977	2450
1978	3200
1979	3100
1980	2900
1981	2930
1982	3325
1983	4257
1984	3600

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* R. Abdin, For Efficient Policies to Developing & Using the Egyptian Energy Resources, op. cit., p.4.

Table (3.6) Egypt Crude Oil Production

According to the Production Zone 1970-1983

(Thousand Metric Tonnes)

Years	Sinai		Eastern Desert		Suez Gulf		Western Desert		Total	
		% Tot		% Tot		% Tot		% Tot		% Tot
1970	X	X	1350	8.2	13446	82	1603	9.8	16404	100
1971	X	X	1406	9.5	12201	82.4	1199	8.1	14806	100
1972	X	X	1455	13.6	7978	74.4	1297	12	10720	100
1973	X	X	1426	17	5016	59	2037	24	8479	100
1974	X	X	1577	21	4289	58	1587	21	7453	100
1975	358	3	1846	16	7842	67	1688	14	11734	100
1976	3455	21	1513	9	10041	61	1559	9	16568	100
1977	3644	18	1352	6	14321	69	1509	7	20846	100
1978	4344	18	1203	4	17377	72	1359	6	24283	100
1979	5097	19	1145	4	18630	71	1437	6	26309	100
1980	5440	18	1181	4	21664	74	1119	4	29404	100
1981	6187	19.5	1245	4	23338	73.5	986	3	31756	100
1982	6744	20.5	1334	4	23936	72.8	878	2.7	32892	100
1983	7255	20	1324	4	26384	73	994	3	35957	100

Source: EGPC, Annual Reports, 1980, 1982, 1983

X Because of the 1967 war.

The above table shows that the Gulf of Suez region remains the major source of Egypt's oil production accounting for 82% of the total production in 1970, 67% in 1980, and 73% of the total oil production in 1983. On the other hand, the Western Desert region represents the least source of Egypt's oil production accounting for only 3% of the total oil production in 1983. This is mainly due to the uneven exploration activities over the territory of Egypt and which in turn led to major differences in the discoveries and thus in production of the four regions.

(3/4/3) Refining Capacity and its Development:

The expansion of the refining industry is a goal of the Egyptian petroleum sector in order to satisfy the domestic consumption and to allow for the export of certain products. Refineries have been set up in different areas instead of concentrating them in Suez area in 1952. Table (3.7) shows the development of refining capacity of the local refineries in Egypt since 1952-1984/85.

This table shows that Egypt's refining capacity reached a record of 20 million tons in 1984/85 i.e. 2.7 times the figure in 1972 and an increase of 14.3% over 1981/82. It also shows that Suez area was the only refining area in Egypt in 1952.

Table (3.7) Refining Capacity of the Local Refineries in Egypt since 1952-1984/5

(Million Tons)

Areas	1952	1972	1977	1981/82	1984/85
Suez	2	-	2	3.5	4.75
Cairo	-	3.5	4.5	4.5	6
Alexandria	-	4	7	8	7.9
Tanta	-	-	0.75	1.2	1
Sinai	-	-	-	-	0.35
Total	2	7.5	14.25	17.2	20

Source: Ministry of Petroleum, Annual Reports, 1977, 1985

Also table (3.8) shows the development of refineries production of refined products since 1970-1983. It shows that refinery throughput in 1983 totalled 18.144 million metric tons i.e. 5.4 times the figure in 1970. The table also shows that refining efficiency decreased from 96.4% in 1970 to 94.8% in 1983. It is noteworthy that domestic refineries could reduce the amount of refinery fuel and losses to 5.2% in 1983 which compares favourably with the world average of 6.5%.[10] The table also shows the growth of quantities of refined products since 1970-1983.

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[10] R. Abdin, For Efficient Policies to Developing & Using the Egyptian Energy Resources, op. cit., p.31.

Table (3.8) Egypt Refineries Production from Petroleum Products since 1970-1983

(Thousand Metric Tons)

Details	1970	1975	1980	1981	1982	1983
Crude Throughput	3371	9134	13834	15071	16810	18144
Products:						
Fertiliser Gases	-	1	9	9.4	9.1	8.3
Propane/Butagas*	9	49	139	167	168.5	226.7
Gasoline/Naptha	490	1335	1983	2054	2213	2223
Kerosine/Turbine	512	1294	1679	1659	1971	2135
Gas Oil/Diesel	557	1607	2521	2612	2693	2862
Fuel Oil	1612	4265	6417	7329	8377	8879
Bitumen	58	118	282	287	378	508
Coal	-	-	-	-	-	12
Basic Oils	-	31	68	67	77.6	121.7
Others	13	14	34	105.6	71	121.3
Total	3251	8714	13132	14291	15958.2	17197
Refining Efficiency	96.4%	95.4%	95%	95%	95%	94.8%

* Butagas figures exclude Butagas produced from natural gas

Source: Ministry of Petroleum, Annual Reports, 1983 & 1984

(3/5) Domestic Consumption of Petroleum Products and its Development

Domestic consumption of petroleum products has been rising rapidly in recent years and in 1983 was more than 16 million tons compared with 5.7 million tons in 1965, 5.9 million tons in 1970, 7.4 million tons in 1975, and 11.3

million tons in 1980 and an increase of about 2 million tons (12.2%) over 1982 (14.5 million tons) as shown in table (3.9) for the period 1975-1983, the average annual growth rate of petroleum products consumption was 9.6% while for the period 1980-1983 it was 11.8% as shown in table (3.10). Table (3.10) also shows that the average annual growth rate of Butagas consumption was the highest among the other fuel products during the period 1975-1983 and 1975-1980.

Table (3.9) Domestic Consumption of Petroleum Products and Natural Gas since 1965-1983

(Thousand Metric Tons)

Years	Butagas	Gasoline	Kerosine	Gasoil	Diesel	Fueloil	Others	Total Products	Natural Gas	Total Consumption
1965	59	287	928	876	248	2974	357	5729	-	5729
1970	108	444	820	995	181	3005	297	5850	-	5850
1975	179	673	1191	1179	134	3623	346	7325	33	7358
1976	211	747	1225	1327	150	4012	369	8041	110	8151
1977	248	837	1305	1484	149	4293	394	8709	362	9071
1978	296	957	1380	1708	140	4382	560	9420	587	10007
1979	339	1041	1486	1891	149	4840	541	10287	852	11139
1980	381	1221	1503	2246	144	5185	234	10914	1578	12492
1981	408	1219	1555	2585	124	5495	924	12315	1810	14125
1982	464	1421	1706	3062	110	5941	850	13554	1921	15475
1983	499	1581	1901	3354	95	7011	804	15251	2167	17418

Source: EGPC, Annual Reports, 1980-1983, Ministry of Petroleum, Annual Reports, 1975-1984

Table (3.10) Average Annual Growth Rate of Domestic Consumption of Petroleum Products 1975-1983

	1975-1980	1980-1983	1975-1983
Butagas	16.3	9.5	13.8
Gasoline	12.7	9.3	11.4
Kerosine	4.8	8.2	6.1
Gas Oil	11.3	14.4	12.5
Fuel Oil	7.5	10.7	8.7
Total Products	8.3	11.8	9.6

Source: Table (3.9)

A further analysis of the petroleum products consumption pattern sheds some more light on the distribution of total consumption over the economic sectors. Since Butagas and Kerosine are consumed mainly in housing and residential sector while Gasoil is consumed mainly in transportation sector, therefore the concentration is on sectoral consumption from Gasoil Mazout and natural Gases. Table (3.11) shows consumption by sectors of Gasoil, Mazout and natural gases in 1982 and 1983. It is noted that electricity comes on top of the consumers of gasoil, mazout and natural gases accounting for 48%, 61.5% and 48.5% of their consumption respectively.

Public transport comes second in the case of gasoil accounting for 21% while industry comes second in the case of mazout and natural gases accounting for 26% and 43.3% respectively. It is noteworthy that industry increased its consumption from gasoil and natural gases in 1983 by about 59% and 34% respectively over 1982.

Table (3.11) Sectors Consumption from Gasoil, Fuel Oil and Natural Gases 1982, 1983

Sectors	Gas Oil (1000 metric tonnes					Fuel Oil (1000 metric tonnes)					Natural Gases (million M3)				
	1982	% total	1983	% total	% change	1982	% total	1983	% total	% change	1982	% total	1983	% total	% change
Transportation	300	22.5	340	21.2	13.3	77	2	50	1	-35.1	-	-	-	-	-
Electricity	696	52	778	48.4	11.8	2705	58	3170	61.5	17.2	851	42	1463	48.5	71.9
Industry	95	7	151	9.4	58.9	1408	30	1343	26.1	-4.6	973	48	1308	43.3	34.4
Housing	68	5	87	5.4	27.9	490	10	571	11.1	16.5	211.4	10	248	8.2	17.3
Agriculture	33	2.5	40	2.5	21.2	-		1							
Ginning Mills & Compressors	2	-	2			11		16	0.3	45.5					
Petroleum Industry	142	11	210	13.1	47.9	2		1		50					
Total	1336	100	1608	100	20.4	4693	100	5152	100	9.8	2035.4	100	3019	100	48.3

Source: EGPC, Annual Report 1983

It is not surprising that electricity sector is the major consumer of petroleum products since electricity is heavily consumed by the industrial and residential sectors. With the announcing of government policy of industrial expansion and economic development which have a history that goes back to 1950s, and which diverted the efforts towards large and almost higher energy consuming industrial schemes, industrial sector became the main consumer of electricity accounting for about 62.6% on average of the total electricity consumption during the period from 1960 to 1980[11], besides being one of the major consumers of petroleum products.

(3/6) Distribution, Transportation and Storage:

The five year plan of the petroleum sector has emphasized the importance of distribution, transportation and storage as a phase of an integrated industry. Accordingly, the following major projects have been executed or are under way.

1. The SUMED (Suez to Mediterranian) pipeline is now operating with a full capacity of 80 million tons per year and is transporting Arab crude from the Red Sea to the Mediterranian Sea. A further enlargement to 120 million tons is under study.

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[11] Ministry of Planning, The Five Year Plan 1982/83 - 1986/87, Cairo, vol. 2, 1982, p.68.

2. A number of pipeline projects have been completed or are under way, the most important of which is a pipeline of 346 kilometers and a capacity of 8 to 15 million tons to transport crude oil from the Gulf of Suez to Suez and Cairo refineries.
3. Storage capacity has been enlarged to cover about 60 days for Gasoline and Kerosine and 45 days for Fuel Oil and Gasoil instead of 15 days in 1973.
4. A network has been completed to transmit natural gas from its production areas to the consumption areas.

(3/6/1) Crude Oil and Petroleum Products Transportation:

Gross volume of crude oil and refined products (except Butagas) transported during 1983 amounted to about 47 million tons i.e. an increase of 5.6% over 1982 as shown in table (3.12). Table (3.12) shows that:

1. 26.7 million tons (57.17. of the gross volume transported during 1983) were pumped through the pipeline network, an increase of 28.4% over 1982;
2. 10 million tons (21% of the total) were carried by coastal tankers in 1983, a drop by 30.5% of 1982 figures. The drop is due to the inauguration of Shukeir/Mostorod crude oil pipeline;
3. 8 million tons (171% of the total) were carried by tanklorries in 1983, i.e. an increase of 10.7% over 1982;

4. 876000 tons (1.9% of the total) were carried by railways, i.e. an increase of 23.9% over 1982;

5. 1.3 million tons (2.7% over of the total) were carried by river in 1983 with an increase of 2.6% over 1982.

Table (3.12) Transported Quantities of Crude and Products During 1982, 1983

(Thousand Metric Tons)

	Coastal Transport		Pipelines		Tank Lorries		Railways		River Transport		Total	
	1983	1982	1983	1982	1983	1982	1983	1982	1983	1982	1983	1982
Crude Oil	9563	13939	17674	12746							27237	26685
Gasoline			194	162	1547	1300	40	45			1781	1507
Turbine			134	69			13				147	69
Kerasine		23	1845	1729	1400	1310	62	44	469	465	3776	3571
Gasoil/Diesel	13	7	2093	1969	2620	2220	99	57	415	411	5240	4664
Fueloil	426	427	4765	4120	2425	2390	662	561	403	378	8681	7876
Total	10002	14296	26705	20795	7992	7220	876	707	1287	1254	46862	44372
% from Total	21.3	32.4	57	46.9	17.1	16.3	1.9	1.6	2.7	2.8	100	100

Source: EGPC, <u>Annual Report</u>, 1983

(3/7) Oil Foreign Trade and its Development:

Before examining the development of Egypt's oil foreign trade, a useful starting point is to examine Egypt's oil pricing policy and its impact on the oil foreign trade of Egypt in particular after the slump in the world oil market which compelled OPEC, for the first time in its history to reduce the official price of its marker crude by five dollars from $34 per barrel to $29.

(3/7/1) Egypt's Pricing Policy:

Egypt's policy for exporting crude oil is based on a system of annual international bidding. At the end of October and the beginning of November every year bidders are invited to submit their tenders for the following year. The following procedure is applied: *

"1. A price is fixed for each type of crude oil on standard terms and conditions for all customers, the highest prices offered by tenders naturally accepted.
2. The prices so fixed remain in application for a period of three months and may be changed according to the circumstances prevailing in the world oil market taking into account competition between Egyptian crudes and other equivalent foreign crudes in the main consuming areas."

This flexible pricing policy has played a positive role in increasing Egypt's exports of crude oil by about one million tons in 1983 over 1982 as shown in table (3.14).

It is noteworthy that the prices of Egyptian crudes were raised four times in 1983 after the announcement by OPEC of the reduction of their crudes by five dollars.

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* See EGPC, The Annual Report, 1983, p.65

Table (3.13) shows the development of crude oil export prices along 1983.

Table (3.13) The Development of Crude Oil Export Prices Along 1983

	Morgan Blend API 33	Gharib Blend API 21.5	Balayim Blend API 26	Ras Badran Blend API 26
Jan	31	26	28	
Feb	29	25	27	
March	27.25	23	25.25	
April	-	-	-	
May	-	23.25	25.75	25.75
June	27.75	-	26	26
July	28.25	23.50	26.25	26.25
Aug	-	-	-	-
Sept	28.50	24.50	26.75	26.75
Oct	-	-	-	-
Nov	-	-	-	-
Dec	-	-	-	-

Source: EGPC, Annual Report 1983

(3/7/2) Oil Foreign Trade:

In the field of international trade, total exports of the petroleum sector have jumped from $62 million in 1973 to $3064 million in 1980 and to $3203 million in 1982. However in 1983 total oil exports have decreased to $2994 million with a drop of 6.5% compared to 1982, despite the fact that exports of crude oil rose from 7.3 million tons in 1982 to 8.3 million tons in 1983 and this is mainly due to oil prices decrease in 1983 as illustrated above. Table (3.14) shows the development of Egypt petroleum sector balance of payments 1960-1983. The table shows that total imports by the sector totaled $183 and reached $411 million in 1980. Table (3.14) also shows that the sector's balance of payments has turned from a deficit in 1975 (and before) of nearly $65 million to a surplus of nearly $2653 million in 1980. This is mainly due to two main factors, the proven increase in crude oil production and the continuous increase in world oil prices.

Table (3.14) also shows that petroleum imports in 1983 cost about $802.6 million with an increase of 7.5% over 1982. This increase in cost was due to increase of quantities of certain imported crude oils and petroleum products. Table (3.15) shows imports of crudes and products in 1983. It will be noted that while imports of Butagas were substantially reduced from 221 thousand tons in 1982 to 195 thousand tons in 1983, imports of gas oil increased from 924 thousand tons in 1982 to 1306 thousand tons in 1983. Imports of Arab crude had to be increased from 346 thousand tons to 525 thousands in order to cope with the requirements of the lube oil complex.

(3/8) Concluding Remarks:

Examining the main features of the Egyptian petroleum industry, the following remarks can be concluded:

Table (3.14) Egypt Petroleum Sector

Balance of Payments (1960-1983)

$ million

Year	Exports	Imports	Balance of Payments
1960	11	55	-44
1965	46	80	-34
1970	79	110	-31
1971	73	120	-47
1972	45	103	-58
1973	62	183	-121
1974	183	412	-229
1975	309	374	-65
1976	631	325	306
1977	711	177	534
1978	930	177	753
1979	1915	254	1661
1980	3064	411	2653
1981	3441	641	2800
1982	3203	746	2457
1983	2994	803	2191

Source: EGPC, Annual Reports, 1980, 1983

1. There are mainly four major factors that stimulated the growth of the Egyptian petroleum industry during the period under study:

a. The attraction of the Egyptian production-sharing concessions and incentives offered by the Egyptian government for encouraging Arab and foreign investment in oil operations;

b. Egypt has certain characteristics which are accountable

Table (3.15) Imports of Petroleum in 1983

	Quantity (1000 tons)	Value (1000 L.E.)
Crude Oil & Gases		
Crude of SUCO Share	72	9406
EXPEDICO	40	5868
Crude of Shell Share	64	10033
Crude of Philips Share	121	17612
Crude of Total Share	15	1892
Gases of AMOCO Share	244	6133
Butagas of AMOCO Share	23	405
Arab Crude	525	80039
Total	1104	131388
Products & Others		
Butagas	195	53168
Jet Fuel	414	82371
Aviation Gasoline	4.7	1350
Gas Oil	1306	222161
Lubricants & Additions		39593
Freight & SUMED Fees		19990
Spare Parts & Chemicals		16851
Invisible Expenditures		571
Total		436055
Total Imports		567443

Source: EGPC, Annual Report, 1983

for the highly comfortable climate enjoyed by foreign investors. To mention but a few of these endowments, there are a deep-rooted spirit of respect for contractual relations and a vast and diversified base of manpower skills which provide elements needed for work and an easy atmosphere to discuss problems and reach fair solutions. In a recent study, Egypt came on top of nearly 40 developing countries where the business climate was termed as "attractive";[12]

c. The high success in oil finding and widely established infrastructure to support production and exploration, and

d. Increases in world demand for oil.

2. There are four main oil producing areas in Egypt. They are Gulf of Suez, the Nile Delta, the Northern half of the Western Desert and the Northern half of Sinai peninsula. The Gulf of Suez is considered to be the most prolific and prospective oil province and therefore exploration activities have been concentrated in it although the other provinces have a very promising hydrocarbon potentials; *

3. The growth of the petroleum industry has been largely evidenced by the growth of its exports either in the form of crude oil or petroleum products although a high percentage of oil exports is in crude oil form. In 1979,

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[12] H. Abdallah, The Energy Situation in the Arab Republic of Egypt, (The Journal of Energy & Development, 1984), p.223.

* For a survey of the geological aspects and hydrocarbon potentials of Oil provinces in Egypt, see N.Choucri & Z.Shafei, Resource Development & Policy in Egypt: Petroleum & Natural Gas, (mit, 1983), pp.25-35 and Y. Zamzan, Geology of Egypt. (The Petroleum, EGPC, Sept. 1984), pp.16-26.

76% of total oil exports was in crude oil form, in 1983, 79% of the total oil exports was in the form of crude, in 1981, 76% of total oil exports was in crude oil form, in 1982 and in 1983, 73% and 74% of total oil exports respectively was in the form of crude oil.[13]

4. The increasing domestic demand for petroleum products is attributed mainly to the low domestic prices of oil. In 1978 for example, "the price of a barrel of crude for domestic consumption was about $4 (including excise taxes and other charges), compared with an export price of $33 a barrel. As a result of this price difference Egypt is losing the opportunity of using its finite petroleum wealth to mobilize domestic financial resources, the shortage of which is becoming the main constraint on investment." [14] Moreover, the subsidy implicit in such a pricing policy encourages wasteful consumption. In the absence of major new discoveries, the peaking oil fields and the sharply rising domestic demand could transform Egypt from an exporter to a net importer in the very near future in particular the oil production/reserve ratio in Egypt is about 6% or more and this is considerably high compared to countries having huge amount of reserves such as US which produce its reserve at a ratio of 10% per year.[15]

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[13] EGPC, Annual Reports, 1980-1983.

[14] K. Ikram, Egypt, Economic Management in a Period of Transition, op. cit., p.281.

[15] M. Amin, The Future & Egypt's Oil Needs, (Petroleum Magazine, EGPC, Cairo, Dec. 1981), p.13.

Chapter (4)

The Direct Impact of the Egyptian Petroleum Sector on the Egyptian Economy

(4/1) Introduction:

The present chapter aims at examining the direct impact of the Egyptian petroleum sector on the Egyptian economy as the first step in estimating the impact of the sector on the economy. Such direct impact has been estimated through the following:

1. The direct contribution to foreign exchange earnings;
2. The direct contribution to the balance of payments;
3. The direct contribution to investment; and
4. The direct contribution to public revenue.

(4/2) The Egyptian Economy since 1952:

Since the main concern of this thesis is to examine the impact of the Egyptian petroleum sector on the Egyptian economy, a useful starting point is to shed some more light on the Egyptian economy. But it is beyond the scope of this thesis to discuss in detail all the features of the Egyptian economy. Therefore, the main objective of the present section is to highlight briefly the main economic changes taken place in the Egyptian economy before and after 1973 in an attempt to analyse the impact of the petroleum sector on the Egyptian economy in particular after 1973 the era where the petroleum sector has become significant in the Egyptian economy.

(4/2/1) Before 1973:

Before 1952, Egypt was a private enterprise economy with foreign influences in many fields and with limited government intervention. The Egyptian economy became a mixed economy, through the nationalization movement, the Egyptianization of foreign interests and direct government investments. But it was not until 1957 that planning on a large scale was introduced in Egypt. In 1960, a comprehensive plan was started in two five years phases 1960-1965 and 1965-1970.[1] The first phase of the plan, however, was criticized on the ground that the methods of project appraisal adopted were mainly the criterion of maximizing the crude value added/capital ratio without making any serious attempt to optimize the sectoral allocation of scarce investable resources. B. Hansen criticized this criterion on the ground that it treats factors of production other than capital,as a free resource. This raises complex problems of the shadow price of these production factors. B. Hansen suggested that the shadow wage of labour should be equal to market wages in agriculture, which tend to reflect the marginal

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[1] For more details see: K. Ikram, Egypt, Economic Management in a Period of Transition, (Johns Hopkins University Press, Baltimore and London, 1980), ch.2.

productivity of labour in that sector.[2] The maximization of foreign exchange savings was another reason often presented for the selection of specified projects by the planning board. This depends on a crude import substitution or self-sufficiency criterion.[3] This method often does not realize its purpose because it neglects comparative advantage and treats all domestic resources as non-tradeables.

Since 1952, the performance of the Egyptian economy has been uneven. Since that year, the economic development of Egypt may be divided as follows: The 1955-65 decade witnessed fairly rapid and sustained economic growth as well as a major structural transformation of the economy. During this period, the gross domestic product (GDP) at market prices increased at an average annual rate of just over 8%.[4] At the same time, industry increased its share of GDP at current factor cost, from 17.6% in 1955/6 to 21.6% in 1965/6. While agriculture and services decreased their shares of GDP at current factor cost, from 32.3% in 1955/6 to 28.5% in 1965/6 for agriculture and from 47.2% in 1955/6 to 44.4% in 1965/6 for services.[5]

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[2] B. Hansen, Employment and Wages in Rural Egypt, (American Economic Review, June 1969), pp.304-307.

[3] H. Chenery, The Application of Investment Criteria, (Quarterly Journal of Economics, Feb. 1953), p.80.

[4] K. Ikram, Egypt, Economic Management in a Period of Transition, op. cit., p.31 Table (3.1).

[5] K. Ikram, Ibid, Table (7) p.400.

In the decade after 1965, the economy could no longer sustain the pace of high economic performance, largely because resources were being diverted to defense, and aid flows from the west were interrupted. The rate of economic growth declined steadily, with a marked fall in the rate of investment and domestic savings (see Table (4.2)).

There were significant turning points in the movements in real GDP from 1950 to 1975 (see Table (4.1)). A study by Hansen and Mead suggests stagnation at the beginning of the period with high rates of growth (5% a year and over) starting in 1957 or 1958.[*] According to both the Hansen-Mead and the official estimates, annual increases in real GDP continued to remain significant every year (except 1961-62) until 1965, when a peak seems to have been reached. The rate of growth then began to decline until it reached a negative value in 1967. This was followed by a short-lived recovery, with small GDP increases in 1972 and 1973.

Between 1952 and 1975 industry tended to grow faster than agriculture, a natural outcome of development strategies consistently pursued since World War II. The annual rate of growth of manufacturing and mining was about 8% in 1955-56 to 1960-61.

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[*] B. Hansen and D. Mead, The National Income of the UAR (Egypt), 1939-52, In S. Goldberg and P. Deane, (eds.), Studies In Short-Term National Accounts and Long-Term Economic Growth, Income and Wealth Series II , (London: Bowes and Bowes, 1965), p.255.

Table (4.1) Gross Domestic Product at Current Prices by Economic Activity, 1960-1980

Millions Egyptian Pounds

Years	Agri-culture	Manufac-turing and Mining	Const-ruction	Electr-icity, Gas & Water	Trans-port & Communi-cations	Trade & Finance	Other Branches	GDP at Factor Cost	Nett Indirect Taxes	GDP at Market Prices
1960	403.8	270.9	45.7	11.0	97.6	137.1	384.0	1350.1	93.1	1443.2
1965	595.3	442.2	93.8	23.8	186.3	174.7	565.3	2081.4	258.7	2340.1
1970	773.0	576.6	122.6	40.9	137.3	234.3	742.0	2626.7	431.7	3058.4
1971	814.4	623.8	119.4	43.9	145.7	251.3	793.8	2792.3	448.8	3241.1
1972	932.9	640.6	118.0	45.0	151.0	279.2	835.2	3001.9	388.0	3389.9
1973	1062.4	689.5	118.1	44.8	158.6	349.3	1041.8	3464.5	341.8	3806.3
1974	1280.0	857.0	129.0	65.0	179.0	630.0	1057.0	4197.0	142.0	4339.0
1975	1468.0	1029.0	243.0	88.0	260.0	772.0	1196.0	5056.0	162.0	5218.0
1976	1744.0	1240.0	279.0	96.0	401.0	954.0	1451.0	6165.0	562.0	6727.0
1977	2038.0	1588.0	357.0	106.0	491.0	1188.0	1766.0	7534.0	810.0	8344.0
1978	2286.0	1945.0	517.0	121.0	689.0	1544.0	1919.0	9021.0	774.0	9795.0
1979	2530.0	3558.0	647.0	132.0	992.0	2067.0	2175.0	12101.0	604.0	12705.0
1980	3427.0	5249.0	761.0	157.0	1311.0	2498.0	2775.0	16178.0	768.0	16946.0

Source: The World Bank, The World Tables, Third Edition, Vol. 1, 1983

Table (4.2) Available Resources and Expenditure At Current Market Prices, 1950-1981

Millions Egyptian Pounds

Years	GNP	Factor Payments To Abroad	GDP	Imports of Goods and NFS	Exports of Goods and NFS	Private Consumption	General Government Consumption	Gross Domestic Investment
1950	918.0	-11.9	929.9			656.0	136.4	109.5
1955	1046.5	-9.5	1056.0			707.4	185.4	154.2
1960	1445.8	2.6	1443.2	290.0	281.7	1017.5	242.0	192.0
1965	2321.9	-18.2	2340.1	499.5	410.4	1559.8	455.4	414.0
1970	3006.6	-51.8	3058.4	573.5	433.8	2015.8	755.7	426.6
1971	3180.4	-60.7	3241.1	612.3	447.0	2139.0	838.7	428.7
1972	3380.1	-9.8	3389.9	648.6	452.5	2258.7	909.0	418.3
1973	3821.6	15.3	3806.3	729.3	532.2	2428.8	1074.0	500.4
1974	4373.0	34.0	4339.0	1616.0	890.0	3191.0	899.0	975.0
1975	5275.0	57.0	5218.0	2154.0	1053.0	3280.0	1298.0	1741.0
1976	7074.0	347.0	6727.0	2287.0	1498.0	3936.0	1670.0	1910.0
1977	8802.0	458.0	8344.0	2770.0	1876.0	5176.0	1628.0	2434.0
1978	10759.0	964.0	9795.0	3626.0	2130.0	6178.0	2012.0	3101.0
1979	13509.0	804.0	12705.0	5804.0	3905.0	8259.0	2172.0	4173.0
1980	17557.0	611.0	16946.0	7992.0	5738.0	10826.0	3263.0	5111.0
1981	19845.0	39.0	19806.0					5947.0

Source: The World Bank, The World Tables, Third Edition, Vol. 1, 1983

This is to be compared with 6.6% between 1960/1 and 1965/6, 4.7% between 1965/6 and 1970/1, and 4.2% in 1971-75. The period of fast industrial growth stretched in fact from 1955-56 to 1964-65 with an average annual rate of around 7.3%. Industrial growth began to slow down after 1965/6 with an annual rate of 0.7% in 1966/7 and - 4.7% in 1967-68.[7] This slow down of industrial growth may be attributable to the adverse impact of external factors such as 1967 war and which affect the rate of investment in the productive sector as well as the problems of performance within industry, arising in part from the inefficiencies of the public sector and the maladministration of prices.

Although industry has grown faster than agriculture in recent decades, this does not necessarily signify that manufacturing has been the leading sector in recent development. Ikram argues that "the expansion of Egyptian industry is the result of protectionist policies pursued in a variety of ways under successive economic systems since 1930".[8] Although there are strong backward linkages with agriculture because textiles and food processing make up a large proportion of industry, industry does not appear to have stimulated major new demands from the agriculture

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[7] K. Ikram, Egypt, Economic Management in a Period of Transition, op. cit., pp.36-7.

[8] K. Ikram, Ibid, p.36.

sector.[9] Also Girgis argues that "the kind of industrialization via import substitution employed in Egypt has contributed positively to industrial output and employment expansion, but negatively to resource allocation and the growth of manufactured exports."[10]

The striking features of macroeconomic developments in 1952-73 period are shown in Table (4.3).

Table (4.3) Percentage Distribution of Expenditure Items in GDP at Current Market Prices, 1955/6 to 1973

	1955/6	1960/1	1965/6	1970/1	1973
Consumption	84.9	85.9	86.4	91.8	92.0
Public	17.3	17.6	19.8	25.6	28.2
Private	67.6	68.3	66.6	66.2	63.8
Gross Investment	16.3	15.5	18.1	13.0	13.15
Domestic Saving*	15.1	14.1	13.6	8.2	8.0
Exports	24.5	19.2	15.3	14.0	14.0
Imports	25.7	20.5	19.8	18.7	19.16

* Domestic Saving is equal to the difference between GDP and Total Consumption.

Source: Table (4.2)

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[9] K. Ikram, Ibid, p.36.

[10] M. Girgis, Industrialization and Trade Patterns in Egypt, (Tubingen: J.C.B. Mohr [Paul Siebeck], 1977), p.1.

Table (4.3) shows that the share of public consumption in GDP at market prices had a marked tendency to rise throughout the 1952-73 period, while the share of private consumption moved around a declining trend line. The share of investment displayed a cyclical pattern of large amplitude, with an upward movement between 1955/6 and 1965/6 followed by a decline in the next five years. The share of domestic saving remained fairly stable between 1955 and 1965, but then began to move along a declining trend line until 1973. The share of exports in GDP fell from some 25% in 1955/6 to as low as 14% in 1970/1. An upward tendency is noticeable thereafter. The import share follows movements that are fairly closely associated with those of investment: a decline between 1955/6 and 1970/1, and a very considerable increase after 1973 as shown in Table (4.2).

"These developments, when related to the preceding analysis of changes in the rate of economic growth, suggest a very simple explanation of macroeconomic behavior in Egypt since the early 1950s. The critical variables which seem to determine the rates of real output growth in the short, and perhaps medium, term are investment and imports. In Egypt the nexus between investment, imports, and growth is very strong, and the recent economic history of the country can be viewed as attempts and failures to raise the investment ratio. The first attempt to raise the ratio from an average rate of about 14% of GDP to 18-20%

was made through planning and public control of the means of production during the first five year plan between 1960 and 1964. The rise in investment ratio was not accompanied by a commensurate increase in the rate of domestic saving, but was financed from abroad. It was short-lived and failed when foreign financial assistance became harder to obtain after political difficulties in particular with the U.S."[11] Thus, both the investment and import ratios were bound to fall when external financing ceased to be forthcoming at the previous rate and the rate of economic growth, as shown earlier, followed the same plunge between 1964 and 1968. However, the rises in consumption and the 1967 war and the defense burden made things worse. The investment ratio stabilized from the late 1960s until 1973 at around 13% of GDP, as shown in Table (4.3).

The problem, then, lies mainly in the small rate of domestic savings not exceeding 14.5% of GNP yearly and continuing deficits in balance of payments.[12]

Since the service of foreign debts is not an easy burden as well as foreign debts are generally subject to the political circumstances with foreign countries, at the same time the rate of domestic saving is small and it is not enough to finance development in Egypt, encouraging foreign investment seems to be a good policy to achieve

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[11] K. Ikram, Egypt, Economic Managementin a Period of Transition, op. cit., p.44.
[12] R. Mabro, The Egyptian Economy 1952-1972, (Clarendon Press, Oxford, 1974), p.182.

economic development objectives in Egypt. Therefore, The Egyptian government issued the law No. 43 of 1974 encouraging the investment of Arabs and foreigners. This law gives privileges to Arab and foreign capital invested in Egypt such as exemption of tax on commercial and industrial profits for a period of five years and also gives guaranties against nationalization and requisition.

One of the main problems that Egypt faces, is the population explosion Egypt is densely populated and generally the rate of population growth is higher. The natural rate of population growth rose substantially in the 1940s and 1950s, reaching an average of 2.3% a year and a peak of 2.5% in the early 1960s, but it declined slowly until about the mid-1970s and then began to increase. Typically, the population explosion was the result of a sudden fall in the death rate unmatched by a decline in birthrates.[13] This high rate of population growth unaccompanied by extra job opportunities, led to an increase in unemployment in Egypt.

The emigration of Egyptians abroad is also another matter. The consequence of large-scale migration for Egypt are twofold. A positive contribution is made to the balance of payments through foreign exchange remittances as shown in Table (4.4). Table (4.4) shows the workers' remittances, their uses and their impact on the balance of current account 1980-84.

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[13] K. Ikram, Egypt, Economic Management in a Period of Transition, op. cit., p.28.

Table (4.4) Workers Remittances, Their Uses and Their Impact on the Balance of Current Account 1980-84[1]

Value in Millions Egyption Pounds

	1980/8	1981/2	1982/3	1983/4	1984/5
(1) Total Workers Remittances	2105.2	1406.7	2327.5	2956.2	2835.8
Cash Savings	854.4	531.1	931	1057	724.3
% of Total	40.6	37.8	40	35.8	25.5
Own Exchange Imports	1250.8	875.6	1396.5	1899.2	2111.4
% of Total	59.4	62.2	60	64.2	74.5
(2) Current Receipts	7228.3	6739.9	7892.6	8732.9	8676.6
Ratio of (1) : (2) %	29.1	20.9	29	33.9	32.7
(3) Current Payments	8360.4	8606.6	8664.5	9849	10136.8
Ratio of (1) : (3) %	25.2	16.3	26.9	30	28

[1] National Bank of Egypt, Economic Bulletin, Vol XXXVIII No 4, 1985

But since migration is selective and tends to remove from the domestic labour force some of the best elements across the full range of professions and skills a cost is incurred. Migration tends to aggravate shortages of skills that are scarce and does little to alleviate unemployment or underemployment of those who are genuinely in excess supply. In addition, the adverse impact of the migration phenomenon is also represented in an increased consumption and imports. Table (4.4) shows that workers' remittances are largely directed to imports and these imports are usually luxurious and consumption goods.

(4/2/2) The Era After 1973:

As a result of the October 1973 War and the Oil revolution, a new situation for the Egyptian economy has been created. This new situation is characterised by the Quest for peace and its economic implications, liberalization, significant external imbalances, and changes in the patterns of foreign indebtedness.

The aim of liberalization policy is to create a new economic system in which public and private sectors match one another in weight and in which the government severely limits the degree of its interference in the economy. It can be argued, however, that some rather timid liberalization had begun as early as 1967 and that the forces working to open up the economic system in favor of the private sector had already acquired some momentum before 1973. The October paper announced by the government after 1973, nevertheless represents such a significant shift in the economy. Although many characteristics of the old economic system remain such as a large concentration of the ownership of modern means of production in the public sector, and extensive state intervention in the operations of product and factor markets, the new system has some new features. The private sector-domestic, Arab, and foreign-is being encouraged to invest, produce, and export. Imports are being allowed in a liberal fashion.

Foreign exchange controls have been relaxed, and the private sector now has easy access to free foreign exchange in the parallel market.[14]

The movement towards liberalization was actually a result of a set of internal and external factors. Internally, the economy was suffering mainly from what is called the "saving-investment gap" as explained before, and externally, the sharp increase in oil prices and the resulting surplus in the Arab World, together with Egypt's new foreign policy, called for a transition of economic policy towards more open and liberalized system.

As a result of such liberalization policy, capital flows from abroad increased from 490.4 million Egyptian pound in 1974 to 933.6 million Egyptian pound in 1978 i.e. an increase of 110.6% over 1974. Whereas the capital flows to abroad increased from 285.5 million Egyptian pound in 1974 to 521.6 million Egyptian pound in 1978 i.e. an increase of 82.7% over 1974. Thus, the foreign capital transactions resulted in surplus of 157.7 million Egyptian pound in 1974 increased to about 412 million Egyptian pound in 1978.[15] More precisely, foreign investment increased from 70 million U.S.$ in 1974 to 440 million U.S.$ in 1978 i.e. an increase of 528.6% over 1974.[16]

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[14] K. Ikram, Egypt, Economic Management In a Period of Transition, op. cit., p.46.

[15] The Central Bank of Egypt, Economic Bulletin, vol. 21 No.1, 1981, p.21.

[16] K. Ikram, Egypt, Economic Management in a Period of Transition, op. cit., Table (16.5), p.347.

The oil revolution which resulted in oil price increases in 1973 and 1979, was the other factor behind the changes taken place in the Egyptian economy after 1973, in general and in the petroleum sector in particular. The steady increase in oil production since 1974 as shown in Table (3.6) and the sharp rise in oil prices characterised the importance of the petroleum sector in the Egyptian economy accounting for about 5.5% of GDP at current factor cost in 1976 increased to 7.2%, 8.2%, 14%, 18.4%, and 18.5% in 1977, 1978, 1979, 1980, and 1981 respectively.[17]

To sum up, the two major changes (i.e. the opening policy, and the increases in oil prices) occurred after 1973, resulted in a development in the economic indicators and the most important one is the increase in the investment rate and in both exports and imports as shown in Table (4.5). Table (4.5) shows that investment increased from 13.15% of GDP at current market prices in 1973 to 30.2% of GDP at current market prices in 1980. On the other hand gross domestic saving increased from 8% of GDP at current market prices in 1973 to 16.9% of GDP in 1980. Although the resource gap defined as the difference between gross investment and domestic saving, increased from 5.2% of GDP in 1973 to 13.3% of GDP in 1980, this can, however reflect the role of foreign capital in financing domestic investment in Egypt.

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[17] The National Bank of Egypt, Economic Bulletin, vol. 36 NO. 1, 1983, p.158.

Table (4.5) Available Resources and Expenditure
At Current Market Prices and Saving
Investment Gap 1973 and 1980

Millions Egyptian Pound

	1973		1980	
	Value	% of GDP	Value	% of GDP
GNP	3821.6		17557	
Net Factor Payments to Abroad	15.6		611	
GDP	3806.7	100.0	16946	100
Imports of Goods and NFS	729.3	19.2	7992	47.16
Exports of Goods and NFS	532.2	14.0	5738	33.9
Total Resources	4003.4		19200	
Private Consumption	2428.8	63.8	10826	63.9
Government Consumption	1074.2	28.2	3263	19.3
Gross Domestic Investment	500.4	13.2	5111	30.2
Gross Domestic Saving	303.3	8.0	2857	16.9
Resource Gap*	-197.1	5.2	-2254	13.3

* Resource Gap is identical to the difference between imports and exports of goods and nonfactor services (NFS)

Sources: Table (4.2)

With respect to the balance of payments, the Egyptian government's balance of payments policy after 1973 aimed at:

"1. Sustaining the very high level of food requirements of the economy;

2. Importing larger quantities of intermediate and capital goods in order to increase capacity utilization and rehabilitate the economy; and

3. Building up stocks of both food and intermediate goods, which had been dangerously depleted."[18]

" Despite the increase in the price of raw cotton, export performance continued to be inadequate to meet Egyptian import requirements, and the volume of most merchandise exports virtually stagnated. The problem was made much more difficult because of the adverse movement in the external terms of trade in 1973-76, largely because of a fourfold increase in the price of imported wheat, unmatched by comparable rises in the price of cotton exports. In 1974 and 1975 the prices of both exports and imports rose unevenly but significantly. Relative prices moved against Egyptian exports by 12% between 1973 and 1974. A more telling indicator is the movement in the cotton export-agricultural imports price ratio, which dropped by some 35% between 1973 and 1974."[19]

However, the adverse movement in the terms of trade is not the only explanation for the deterioration in the balance of payments. Both import and export volumes moved very unfavourably for the balance of payments. After 1973,

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[18] K. Ikram, Egypt, Economic Management in a Period of Transition, op. cit., pp.346-7.

[19] K. Ikram, Ibid., p.47.

import volumes increased and exports decreased. The expansion in domestic demand (for both consumption and investment) seems to have stimulated imports and diverted exports (other than petroleum) away from foreign into domestic markets. The deficit in goods and services accordingly increased from 223.3 million Egyptian pound in 1973 to 498.4 million Egyptian pound in 1978.[20]

In the 1973-78 period the deficit was largely financed through grants from Arab countries, capital flows on concessional terms from Arab and OECD countries, and multilateral institutions such as the World Bank. During this period, however, the direction of capital inflows changed: at the end of 1974 the main creditors (in order in size) were the Soviet Union, The Federal Republic of Germany, Kuwait, and The United States; at the end of 1976 they were Kuwait, Saudi Arabia, The United States, The Soviet Union and The Federal Republic of Germany.[21]

The above brief survey of the Egyptian economy shows the main changes taken place in the economy before and after 1973. However, it can be argued that despite the changes in some important variables, there is a remarkable degree of continuity in objectives (economic development, protection of low income groups and external financing).

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[20] The Central Bank of Egypt, Economic Bulletin, vol. 21 No. 1, 1981.

[21] K. Ikram, Egypt, Economic Management in a Period of Transition , op. cit., p.47.

However, the means of achieving these objectives were different. Economic development was the objective behind the expansion of the public sector and the creation of a planned economy in the late 1950s and early 1960s. This was also the reason behind adopting a liberalized policy to enhance development by interacting with the outside world.

Having examined the main features of the Egyptian economy and the main changes which have occurred in it, the study turns into examining the direct impact of the Egyptian petroleum sector on the Egyptian economy and to what extent it contributed to economic development of the economy.

(4/3) The Direct Contribution to Foreign Exchange Earnings:

When examining the direct contribution of the petroleum sector to Egypt's foreign exchange earnings, the nominal value of exports is not the relevant variable and it might give relatively little meaning. What really matters in the context of the Egyptian petroleum industry, are the amounts of foreign exchange that the petroleum industry actually brings into the country. These amounts are known in the literature on the analysis of the primary export sector in developing countries as the retained values, i.e. "that portions which are retained by the domestic economy."[22]

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[22] D.A. Brodsky and G.P. Sampson, Retained Value and the Export Performance of Developing Countries, (Jounal of Development Studies, vol.17 Oct. 1980). p.32, and R.F. Mikesell, et.al., Foreign Investment in the Petroleum and Mineral Industries: Case Studies of Investor - Host Country Relations, (Baltimore and London: The John Hopkins Press, 1971), p.131.

In the literature there are a variety of definitions of retained value, and their suitability depends very much on the use to which they are put. "While each of the measures may theoretically be computed in terms of either domestic currency or foreign exchange, most have a more natural interpretation in terms of one currency or the other".[23]

Brodsky and Sampson define retained value (RV) in terms of (a) returns to domestic factors, and (b) exchange earning availability.[24]

(a) Returns to domestic factors:

$$RV_1 = L_d + K_d + M_d + R$$

where L_d represents payments to domestic labour,

K_d = payments to domestic capital,

M_d = payments to intermediate inputs, and

R = rents defined to include total government revenue from the industry.

(b) Exchange earning availability:

$$RV_2 = L_d + K_d + M_d + R + K_f$$

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[23] D.A. Brodsky and G.P. Sampson, Retained Value and the Export Performance of Developing Countries, op. cit., p.36.

[24] D.A. Brodsky and G.P. Sampson, Ibid, p.36.

where K_f represents foreign addition to the capital stock through investment, the rest are defined as before.

Mamalakis and Reynolds refer to retained value as "returned value" (R) and define it thus:[25]

$$R = O + C + T_d + D + M$$

where: R = gross returned value representing operating and investment expenditures of the export industry in the local economy,

O = all payments to local factors of production,

C = returned value of capital expenditures including all payments to local factors of production for gross investment,

T_d = all direct taxes paid locally,

D = duties on imports paid locally,

M = miscellaneous local expenses including indirect taxes and export duties.

Because of the available data and it was difficult to get data to calculate retained value of the petroleum industry using the above measurements of retained value, the following method has been adopted in order to compute the retained value of the Egyptian petroleum industry's exports.

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[25] M. Mamalakis and C.W. Reynolds, Essays on the Chilean Economy, (Richard D. Irwin, Inc. Homewood, Illinois, 1965), pp.277-278.

$$RV = TR - TM - TC$$

where RV = retained value of the petroleum industry

TR = total resources of the petroleum industry (visible and invisible).

TM = total imports and services

TC = total commitments

(1) Total Resources of the Petroleum Industry:

a. Visible resources consist mainly of oil export proceeds (crude and refined products), bunker, air craft refuelling, and others.

b. Invisible resources consist mainly of services rendered by EGPC including signature bonus paid by the concessionaire to the EGPC according to certain concession agreements; royalty from the Arab Petroleum Pipelines Co. (SUMED); dividends received as a result of EGPC's share of other companies' profits and recovered from International Bank.

(2) Total Imports and Services:

Total imports consists of commodity imports, capital imports and imports purchased by EGPC from foreign partner. While service imports consist mainly of burdens of loans sought by EGPC from commercial banks and Arab and International funds.

(3) Total Commitments:

They include other commitments of EGPC such as installments of loans and energy bonds.

Table (4.6) shows the development of the Egyptian petroleum industry's retained value during 1979-1984. Retained value has increased from U.S.$1200 million in 1979 to U.S.$1890 million in 1984.

Table (4.6) Retained Value of the Egyptian Petroleum Industry 1979-1984

(US$ million)

Years	TR	TM	TC	RV
1979	1580.5	367.03	13.45	1200
1980	2792.12	616.95	25.17	2150
1981	3356.22	842.53	178.69	2335
1982	3599.82	1026.8	299.02	2274
1983	3165.55	1093.74	116.81	1955
1984	3047.63	1142.06	15.57	1890

Source: EGPC, Annual Reports, 1980-1984

Table (4.6) also shows that 1982 represents a turning point, since retained value of the petroleum industry started to decrease. Although total resources in 1982 increased by U.S.$243.6 million over 1981, the retained value decreased from U.S.$2335 million in 1981 to U.S.$2274 million in 1982. This is due to increases in expenditure components (total imports and total commitments) from

U.S.$1021.22 million in 1981 to U.S.$1325.82 million in 1982. After 1982, the decrease in the retained value is due mainly to the decrease in total resources and which in turn could be attributable mainly to the decrease in the amount and the value of oil exports.

For more understanding of the direct contribution of the petroleum sector to foreign exchange earnings, it is of interest to consider other sources of Egypt's foreign exchange earnings. Table (4.7) shows the main sources of foreign exchange earnings in Egypt including retained value of petroleum industry, workers' remittances, Suez Canal dues, cotton exports and tourism revenues, and their impact on the balance of current account, 1980-1984.

Table (4.7) reveals that retained value of petroleum sector comes first among the main sources of Egypt's foreign exchange earnings and accounted for about 19.3% on average of the total value of receipts in the balance of current account during the period 1980-1984. The petroleum sector's retained value also covered about 16.5% on average of the total value of current payment during the same period. Table (4.7) also shows that the petroleum sector's retained value as a source of foreign exchange is subject to fluctuations according to the conditions prevailing in the World Oil market which witnessed lately a sizeable decline with the beginning of 1983.

Table (4.7) The Main Sources of Egypt's Foreign Exchange Earnings and the Balance of Current Account 1980-84

(US$ million)

	1980	1981	1982	1983	1984
(1)Current Receipts	10326.14	9628.4	11275.14	12475.6	12395.14
(2)Current Payments	11943.43	12295.14	12377.86	14070	14481.14
(3)Oil Sector's Retained Value	2150	2335	2274	1955	1890
Ratio of (3) : (1) %	21	24.25	20.2	15.7	15.25
Ratio of (3) : (2) %	18	19	18.4	13.9	13.05
(4)Workers Remittances	1220.6	758.7	1330	1510	1034.7
Ratio of (4) : (1) %	11.8	7.9	11.8	12.1	8.35
Ratio of (4) : (2) %	10.22	6.2	10.74	10.73	7.15
(5)Suez Canal Dues	780.43	908.86	956.6	974	896.7
Ratio of (5) : (1) %	7.6	9.44	8.5	7.8	7.23
Ratio of (5) : (2) %	6.53	9.4	7.73	6.92	6.2
(6)Cotton Exports	326.3	291.43	314.43	459	1059.7
Ratio of (6) : (1) %	3.2	3.03	2.8	3.7	8.55
Ratio of (6) : (2) %	2.73	2.4	2.54	3.3	7.32
(7)Tourism Revenues	590.7	453.6	353	332	474.6
Ratio of (7) : (1) %	5.7	4.7	3.13	2.7	3.83
Ratio of (7) : (2) %	4.95	3.7	2.85	2.36	3.3

US$ = 0.7 Egyptian Pound

Sources: Table (3.6) and National Bank of Egypt, Economic Bulletin, Vol XXXVIII No 4, 1985

(4/4) The Direct Contribution to the Balance of Payments:

The direct impact of the petroleum sector on the balance of payments has been examined through its impact on the trade balance. Table (4.8) shows the role played by petroleum surplus[26] in covering Egypt's trade deficit during the period 1978-1983.

Table (4.8) reveals the following:

(1) Egypt's non-oil trade balance suffers from a continuous deficit during the period under review;

(2) Oil exports represent a large part of total exports and accounted for 28% of total exports in 1978 increased to 66.24% in 1982. However, in 1983, the share of oil exports in total exports decreased to 62.25%. This is due mainly to the slump in the world oil market and which led oil price to drop by five dollars from $34 per barrel to $29 in 1983. This situation led in turn Egypt's oil exports to drop by 6.5% in 1983 compared to 1982, despite the fact that the amount of exports of crude oil rose from 7.3 million tons in 1982 to 8.3 million tons in 1983;[27]

(3) Oil imports represent a relatively small portion of total imports and accounted for only 2.7% in 1978 increased to 8.6% in 1980. However in 1981 decreased to 6.45% increased to 8.3% in 1982 and decreased to 7.9% in 1983;

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[26] Petroleum Surplus is meant to be the difference between visible petroleum exports (i.e. crude and products) and visible petroleum imports, i.e. the surplus of petroleum trade balance.

[27] EGPC, Annual Report, 1983, p.67.

Table (4.8) Egypt's Trade Balance and the Rate of Oil Surplus in Covering Trade Deficit, 1978-1983

(Millions Egyptian Pounds)

Years	Total Exports	Oil Exports		Non-Oil Exports	Total Imports	Oil Imports		Non-Oil Imports	Non-Oil Trade Balance (1)	Oil Trade Balance (2)	Ratio of (2):(1)%
		Value	% of Total Exports			Value	% of Total Imports				
1978	679.8	188.6	28	491.2	2632.2	71	2.7	2561.2	-2070	+117.6	5.7
1979	1287.8	535.4	41.6	752.4	2686.2	179	6.7	2507.2	-1754.8	+356.4	20.3
1980	2132.2	1370.6	64.3	761.6	3402	291	8.6	3111	-2349.4	+1079.6	46
1981	2263	1457.3	64.4	805.7	6187.5	399	6.45	5788.5	-4982.8	+1058.3	21.24
1982	2184	1446.7	66.24	737.7	6354.5	528	8.3	5826.5	-5089.2	+921.7	18.11
1983	2250.3	1400.7	62.25	849.6	7192.7	567	7.9	6625.7	-5776	+833.7	14.4

Sources: The National Bank of Egypt, <u>Economic Bulletin</u>, Vol 36, No 1 1983, The Central Agency for Public Mobilisation and Statistics, <u>The Statistical Year Book</u>, 1984 and EGPC, <u>Annual Reports</u>, 1980-1983.

(4) As regards the role played by petroleum surplus in covering the trade deficit, it has been shown that such surpluses cover a relatively large part of non-oil trade deficit and accounted for about 21% on average of such deficit during the period under review. It has been also noted that the percentage share of petroleum surplus of non-oil trade deficit decreased from 46% in 1980 to 14.4% in 1983. This decline is due to the decline in the World Oil market as explained before.

To sum up, the above brief survey of the direct contribution of petroleum sector to Egypt's trade balance reveals that petroleum surplus has played a major role in covering non-oil trade deficit during the period under review. However, on the other hand, such role is subject to fluctuations according to the conditions prevailing in the World Oil market. Since these conditions of the World Oil market in particular Egypt can be considered to be a price taker, are uncontrollable, it becomes very important to rationalize domestic oil consumption especially it has been rising rapidly in recent years as explained before in section (3/4), in order to increase the amount of oil available for export or/and reduce the rate of oil depletion.

(4/5) The Direct Contribution to Investment:

There is unanimous agreement among economists that investment plays a vital role in economic development process of developing countries. W.W. Rostow defines the process of "take-off" into sustained growth in terms of a critical ratio of investment to national product. He argues that "investment must rise to a level in excess of 10 percent of national income in order for per capita income to rise sufficiently to guarantee adequate future levels of saving and investment since the take-off stage is a short stage of development during which growth becomes self-sustaining."[28] H. G. Johnson, too, sees capital accumulation in its widest sense as the distinguishing characteristic of development, and the structural transformation of economies as a generalized process of capital accumulation. "The condition of being "developed" consists of having accumulated, and having established, efficient social and economic mechanisms for maintaining and increasing large stocks of capital per head in the various forms. Similarly, the condition of being "underdeveloped" is characterised by the possession of relatively small stocks of the various kinds of capital, and the existence of relatively weak and inefficient mechanisms for maintaining and increasing those stocks,

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[28] W. W. Rostow, The Stages of Economic Growth, (Cambridge University Press, 1962), pp.39-41.

particularly of inefficient mechanisms for co-ordinating the growth of the various forms of capital so as to keep the rates of return on them roughly in alignment, and high enough to encourage accumulation."[29] Also in the study of economic growth, empirical evidence reveals that wide interest attaches to the proportion that capital formation constitutes of national product. The larger it is (i.e., the larger the part of current product retained for use in further production), other conditions being equal, the higher the rate of growth of national product that can be generated.[30]

By attracting massive inflow of foreign capital into the country, the Egyptian petroleum industry has made a noteworthy contribution to the Egyptian economy. Table (4.9) shows the development of investments in the petroleum industry and the role of foreign investment during 1974-1983.

Table (4.9) shows that total investment in the petroleum industry increased from 48 million Egyptian pound in 1974 to 1226 million Egyptian pound in 1983. However, in 1982, investment exceeded the figure of 1983. This is due to the fact that foreign companies invested less amount of capital in 1983 than in 1982. This may be explained by the decline in the World Oil market and the drop of oil

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[29] H.G. Johnson, New Developments in the Theories of Trade and Growth, (The Pakistan Development Review,. vol. IX No. 1, Spring 1969), p.9.

[30] S. Kuznets, Six Lectures on Economic Growth, (The Free Press of Glencoe, Illinois, 1959), p.70.

Table (4.9) Investment in the Petroleum Industry and its Decomposition, 1974-1983

Millions Egyptian Pound

Years	Total Investment	Domestic Partner		Foreign Partner	
		Value	% of Total	Value	% of Total
1974	48	32	66.7	16	33.3
1975	160	40	25	120	75
1976	242	46.8	19.3	195.2	80.7
1977	232.9	78.4	33.7	154.5	66.3
1978	202.7	66.4	32.8	136.3	67.2
1979	398	124	31.2	274	68.8
1980	513	156	30.4	357	69.6
1981	903	312	34.6	591	65.4
1982	1702	397	23.3	1305	76.7
1983	1226	414	37.8	812	66.2

Sources: For the period 1974-1978: National Bank of Egypt, Economic Bulletin, Vol 36 No 1, 1983 and for the period 1979-1983: EGPC, Annual Reports, 1980-1983

prices in 1983 and which in turn affected foreign oil companies activities.

Table (4.9) also reveals that foreign investment played a vital role in the Egyptian petroleum industry during the period under review in particular after 1975 and it accounted for about 69% on average of total investment in th industry during the period 1979-1983. It may be noted, however that foreign investment's share of the total investment in the petroleum industry decreased from 76.7%

in 1982 to 66.2% in 1983. This is due to, as explained above, the decline in the World Oil market and which affected foreign companies activity.

In the period 1973-1981 total investment in the Egyptian economy increased from year to year. Table (4.10) show the gross domestic investment in the Egyptian economy at current market prices and its share of GDP during 1973-1981. It also shows the percentage share of investment in the petroleum industry of total investment in the economy during the period under review. In 1973, total investment was 500.4 million Egyptian pound or 13.15% of the GDP rising to 5947 million Egyptian pounds in 1981 or 30% of the GDP. The average annual growth rate of investment in 1973-81 period was 39% and which is considerably high. This high increase in investment reflects the effects of the opening policy and the expansion of petroleum industry activities and which in turn attracted Arab and Foreign investment.

Table (4.10) also shows that the percentage share of investment in petroleum industry of total investment in the economy increased from 6.4% in 1973 to 15.2% in 1981 or 8.3% on average during the period under review. This reflects the importance of the petroleum sector in the Egyptian economy in terms of its contribution to total investment in the economy. The increase in petroleum industry investment can be explained by the increase in the number of oil agreement to a total of 89 agreements

Table (4.10) Total Investment in the Egyptian Economy and its Share of the GDP and Investmentin the Petroleum Industry at Current Market Prices, 1973-1981

Millions Egyptian Pound

Years	GDP	Total Investment		Investment in the Oil Industry	
		Value	% of GDP	Value	% of Total Investment
1973	3806.3	500.4	13.15	32	6.4
1974	4339	975	22.5	48	4.9
1975	5218	1741	33.4	160	9.2
1976	6727	1910	28.4	242	12.7
1977	8344	2434	29.2	232.9	9.6
1978	9795	3101	31.7	202.7	6.54
1979	12705	4173	32.85	398	9.5
1980	16946	5111	30.2	513	10.03
1981	19806	5947	30.03	903	15.2

Sources: Table (4.2) and National Bank of Egypt, Economic Bulletin, Vol 36 No 1, 1983

covering a total area of 712939 km^2 in the period 1973-1983 compared to only 6 agreements in the period 1963-1973.[31] This reflected the expansion of foreign

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[31] EGPC, The Introduction to the Petroleum Industry, op. cit., p.101, and EGPC, Annual Report, 1983, p.23.

companies activity and the increase in their investment in the petroleum sector as shown in Table (4.9).

(4/6) The Direct Contribution to Public Revenue:

The government revenue in Egypt, is defined as the sum of tax revenue divided into direct and indirect taxes; and other non-tax revenue. Transferred profits and investment self-financing are grouped together which defines 'public economic sector surplus'. Total public revenue is defined as the sum of total government revenue and public economic sector surplus as shown in Table (4.11).

One of the main features of total public revenues that they are quite susceptible to exogenous influences. These exogenous influences are transmitted through the growing dependence of the budget on petroleum and Suez Canal revenues. Table (4.11) shows that the ratio of exogenous revenue (i.e. petroleum and Suez Canal revenue) to total revenue increased from 11% in 1975 to 35% in 1980/81. More importantly, the ratio has fluctuated quite significantly, jumping from 15% in 1979 to 35% in 1980/81 and then falling to 27% in 1981/82.

Further more, during the same period i.e. 1976-1981/82, business profit tax grew at average annual growth rate of 47%. This very rapid growth in business profit tax is partly due to the tax contribution of petroleum and Suez Canal. During the period under review, petroleum and Suez Canal profit tax accounted for 27% in 1976 to 52% in

Table (4.11) Total Public Revenues and the Impact of Petroleum and Suez Canal Revenues, 1976-1981/82

(Million Egyptian Pound)

	1976	1977	1978	1979	1980/81	1981/82
Indirect Taxes	907	1416.3	1421.3	1671.5	2354.9	2740
-Foreign Trade	537.8	979.4	919.8	905	1329.4	1573.2
-Consumption	283.6	339.7	360.3	566	699.7	812.6
-Others	85.6	97.2	141.2	199.7	325.8	354.4
Direct Taxes	415.6	551.3	725.8	870.1	1824	1944.7
-Personal Income	47.7	54.9	51.9	55.1	73.2	85.4
-Business Profit	277.6			655.7	1506.3	1577.7
-Others	90.3	109.2	135.5	159.3	244.5	281.6
Total Tax Revenue	1322.6	1967.3	2147.1	2541.6	4178.9	4684.9
Non-Tax Government Revenue	118.8	135.7	147.2	267.2	494	587
Total Government Revenue	1441.4	2103	2294	2808.8	4672.9	5271.9
Public Economic Sector Surplus	573.9	652.4	1012.3	875	2699.9	2958.7
-Transferred Profits	242.9	384.4	539.3	501	1735.5	1714.7
-Investment Self-Financing	331	268	473	374	964.4	1244
Total Public Revenues	2015.3	2755.4	3306.3	3683.8	7372.8	8230.6
Exogenous Revenue	217	398	497	690	2588	2250
-Ratio of Exogenous Revenue to Total Revenue	0.11	0.14	0.15	0.19	0.35	0.27
Petroleum and Suez Canal	75.24	141.3	252.8	251.6	875.3	818.75
-Ratio of Petroleum and Suez Canal Tax Profit to Total Business Profit Taxes	0.27	0.365	0.47	0.384	0.58	0.52

Source: S.Ahmed, Public Finance in Egypt, Its Structure and Trends, (World Bank Staff Working Papers, No 639, 1984)

1981/82 of total profit tax. However, this percentage share decreased from 58% in 1980/81 to 52% in 1981/82.

"The fluctuations in the fiscal contribution of petroleum and Suez Canal can be however, explained by two interrelated factors: The fluctuations in the World Oil prices and the fluctuations in the levels of economic activities in the Western World. International oil prices reached an all time peak during 1980/81 period, the weighted average crude oil price for Egypt stood at U.S.$33.29 a barrel. Economic depression in the Western World which set in around the end of 1981, coupled with a basic disequilibrium in the World Oil market caused by significant 'chiseling' activities within the OPEC Oil Cartel, generated an excess supply situation in the international oil market which forces the oil price down. The Egyptian average crude oil price fell to U.S.$29.8 a barrel in 1981/82. Economic depression slowed the flow of Suez Canal traffic as well causing a reduction in the Suez earnings during 1981/82."[32]

It can be concluded from the above brief discussion that the petroleum sector and Suez Canal contributed fairly well to public revenue during the period under review. However, such contribution is quite susceptible to the conditions prevailing in the World Oil market and the fluctuation in the levels of economic activities in the

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[32] S. Ahmed, Public Finance In Egypt, Its Structure and Trends, op. cit., pp.11-13.

Western World. In addition, the fiscal contribution of the petroleum sector is also quite sensitive to the relative weight of domestic consumption in particular petroleum products subsidy reached to about 1462.7 million Egyptian pound in 1980 or 67.5% of total subsidy and about 14% of total public expenditure in 1980.[33] This reflects the importance of domestic oil consumption rationalization in order to reduce oil subsidy and increase the amount of oil available for export and then the fiscal contribution of petroleum sector could be increased.

(4/7) Concluding Remarks:

(1) Examining the main changes which have taken place in the Egyptian economy before and after 1973, the study has shown that the economy has experienced a transition from a system characterized by public ownership of means of production and rigid regulations on foreign trade before 1973, to a more liberalized system and the re-emergence of an active private sector after 1973 or 1974. However, it is noteworthy that despite of such change in the economic system or in some economic variables, there is a remarkable degree of continuity in objectives (i.e. economic development, protection of low income groups and external financing). However, the means of achieving these objectives were different.

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[33] EGPC, Annual Report, 1980, and S. Ahmed, Public Finance In Egypt, Its Structure and Trends, op. cit.

The brief survey of the main changes in the Egyptian economy before and after 1973, has also revealed that there have been two main factors have led to the main economic developments which have occurred in the Egyptian economy in particular after 1973. These two factors are the opening policy and the oil revolution resulting in the increases in oil prices.

(2) Examining the direct contributions of the petroleum sector to the Egyptian economy measured by a number of indicators directly related to the level of foreign exchange earnings, balance of payments, investment and public revenue, the study has revealed the importance of this sector in the Egyptian economy.

However for the purpose of measuring the direct and indirect impact of the petroleum sector on other sectors in the economy and on national income and its components, the approach presented in the foregoing investigation (i.e. measuring the direct contribution of the sector to the economy), is not sufficient. Therefore and for better understanding of the overall impact of the petroleum sector on the Egyptian economy, an input-output and a macro-economic approaches have been used in the subsequent two chapters.

CHAPTER 5

The Linkage and the Multiplier Effects of the Egyptian Petroleum Industry : An Input - Output Approach

(5/1) Introduction

In Chapter (2), two main theories have been examined. First the economic theory which addresses the role can be played by the primary exports in economic development of developing countries. In general, there have been two main schools of thought regarding the contribution of primary exports to economic development of developing countries: one considered primary exports or international trade has contributed to economic development of developing countries; and the other considered it as having a negative effect on economic development of developing countries. Secondly, the theory which identifies leading sectors in economic development process on the basis of this theory, oil sector comes out fairly well as a good leading sector.

However, in the case of Egypt, whether it is true or not that oil sector contributes fairly well to economic development process is a matter for empirical investigation. Therefore, the present and the next chapters attempt to investigate empirically the impact of oil sector on the Egyptian economy. The latter deals with a macro-economic approach to consider the impact on economic aggregates (i.e. national income, balance of payments etc). On the other hand, the present chapter deals with the application of the input-output model to evaluate two main effects. First, the interindustry linkages of the oil sector with the rest of the economy, and secondly the economic multipliers generated by the growth in the final demand for the output of the oil sector. Before testing such effects, the input-output model has been examined at first, to assess its applicability to developing countries which exhibit a substantial dependence on foreign trade in particular import of inputs for their domestic industries. Also, before assessing the above two main effects, the input-output tables have been used in examining the major changes which have taken place in the Egyptian economy.

The data used for the impact estimates (in this chapter) have been taken from the Egyptian input-output tables of 1977 and 1979 and they are presented in Appendix (A). For the purpose of inter-sectoral comparison of the impact of each sector of the economy, the sectors of the original 1977 and 1979 tables have been aggregated into ten[1] sectors since it is sufficient to cover the major sectors of the economy. In this model, the oil industry is represented by two sectors: oil production

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[1] This is similar to the division done by N. Choucri & Z. Shafei, Resource Development & Policy in Egypt: Petroleum & Natural Gas, Summary and Conclusion, MIT, January 1983.

and mining; and oil refining and coal which produce two different types of commodities, i.e. crude oil and petroleum products.

The following are the composition of sectors used in this study:

Sector (1) Agriculture (Staple food; non-staple food; cotton; other agriculture)

Sector (2): Construction (Construction; housing)

Sector (3): Heavy Industry (Chemical industry; basic metals; metallic products)

Sector (4): Light Industry (Food industry; beverage industry; tobacco industry; spinning & weaving industry; final wear industry; wood & wood products; paper & paper products; publishing & printing; leather & leather products; rubber; non-metallic products; non-electrical machinery; electrical machinery; means of transport; miscellaneous industry)

Sector (5): Transportation (Transportation; communication & storage)

Sector (6): Rest of Economy (Tourism; other services; miscellaneous industry)

Sector (7): Suez Canal (Suez Canal)

Sector (8): Oil Production & Mining (Mining & quarrying; crude oil)

Sector (9): Oil Refining & Coal (Petroleum products; and coal)

Sector (10): Electricity (Electricity)

(5/2) The Input-Output Analysis

An input-output table describes the flow of goods and services between all the individual sectors of a national economy over a stated period of time. These relationships are expressed as a ratio or coefficient of each input to the total output of which it becomes a part[2], i.e.

$$a_{ij} = \frac{X_{ij}}{X_j} \quad \text{i.e.} \quad X_{ij} = a_{ij}\, X_j \qquad i,j = 1,2,\ldots,n \qquad (1)$$

where

a_{ij} = the input coefficient

X_j = gross output of sector j

X_{ij} = the quantity of the product of sector i absorbed by sector j

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[2] W. Leontief, Input-Output Economics, (Oxford University Press, 1966), pp.134-5.

<u>(5/2/1) The Input-Output Model</u>

Assuming that the national economy is subdivided into n+1 sectors, n represents the producing sectors and n+1th final demand sector, the balance equation between the total output and the combined inputs of the product of each sector can be described in matrix form as follows:

$$X_i = \sum_{j=1}^{n} X_{ij} + F_i \qquad (2)$$

where

X_i is the vector of gross output of sector i

X_{ij} is sales of sector i to sector j

F_i is vector of final demand for output of sector i

Substituting equation (1) into equation (2) we obtain:

$$X_i = \sum_{j=1}^{n} a_{ij} X_j + F_i \qquad (3)$$

Given the level of final demand, the input-output system of balance equation depicted by equation (3) can be solved for n unknown levels of output of producing sectors in terms of known final demand for each sector's output. This general solution can be derived as follows:

Equation (3) can be expressed in the following multi-equations:

$$
\begin{aligned}
X_1 &= a_{11}X_1 + a_{12}X_2 + \ldots + a_{1n}X_n + F_1 \\
X_2 &= a_{21}X_1 + a_{22}X_2 + \ldots + a_{2n}X_n + F_2 \\
&\ \ \vdots \\
X_n &= a_{n1}X_1 + a_{n2}X_2 + \ldots + a_{nn}X_n + F_n
\end{aligned}
$$

Transferring all the X's to the left hand side we obtain the following set of simultaneous equations:

$$
\begin{aligned}
X_1 - (a_{11}X_1 + a_{12}X_2 + \ldots + a_{1n}X_n) &= F_1 \\
X_2 - (a_{21}X_1 + a_{22}X_2 + \ldots + a_{2n}X_n) &= F_2 \\
&\ \ \vdots \\
X_n - (a_{n1}X_1 + a_{n2}X_2 + \ldots + a_{nn}X_n) &= F_n
\end{aligned}
$$

Then:

$$
\begin{aligned}
(1-a_{11})X_1 - a_{12}X_2 - \ldots\ldots\ldots - a_{1n}X_n &= F_1 \quad (4) \\
-a_{21}X_1 + (1-a_{22})X_2 - a_{23}X_3 \ldots -a_{2n}X_n &= F_2 \\
&\ \ \vdots \\
-a_{n1}X_1 - a_{n2}X_2 \ldots\ldots\ldots\ldots (1-a_{nn})X_n &= F_n
\end{aligned}
$$

In matrix form equation (4) can be written as follows:

$$\begin{bmatrix} (1-a_{11}) & -a_{12} & \dots & -a_{1n} \\ -a_{21} & (1-a_{22}) & \dots & -a_{2n} \\ \cdot & & & \cdot \\ \cdot & & & \cdot \\ -a_{n1} & -a_{n2} & \dots & (1-a_{nn}) \end{bmatrix} \begin{bmatrix} X_1 \\ X_2 \\ \cdot \\ \cdot \\ X_n \end{bmatrix} = \begin{bmatrix} F_1 \\ F_2 \\ \cdot \\ \cdot \\ F_n \end{bmatrix}$$

This matrix system can then be written in abbreviated form:

$$[\,I - A\,]\,X = F$$

where

I is identity matrix

A is the coefficients matrix

Solving X in terms of F then:

$$X = [\,I - A\,]^{-1}\,F \qquad (5)$$

where

$[\,I - A\,]^{-1}$ is the inverse of $[\,I - A\,]$

The above equation is valid under the following assumptions:

"(1) There are no joint products, i.e. each industry produces only one product.

(2) The technical coefficients are fixed, i.e. no substitutability between inputs, so that input functions are linear and the marginal input coefficient is equal to the average.

(3) The total effect of carrying on several activities is the sum of the separate effects, ruling out external economies and diseconomies, and last, the technical progress is static and production is subject to constant returns."[3]

However, these above assumptions are open to criticism, especially over the long run. Over the long run, the changes in the ratio of factor prices, and technical progress, may alter input-output coefficients substantially in physical terms. Similarly, the composition of demand is liable to considerable change in the long run. If commodities with different input coefficients are grouped together in the same sectors, a changing pattern of demand will alter a sector's input-output coefficient automatically. "To overcome this problem, however, it is common to use the similarity of input structures as a criterion for the aggregation of activities in the original input-output table".[4]

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[3] A.P. Thirwall, Growth and Development, With Special Reference to Developing Economies, (Macmillan Press Ltd., London, 1983), pp.245-7.

[4] A.P. Thirwall, Ibid, p.247.

The input-output could also be criticized on the grounds that as a result of technical change, increasing returns to scale and the changing structure of international trade, the marginal input coefficient may differ from the average input coefficient on which the model is built. This divergence could lead to inaccurate forcasts of the need for certain commodities on the basis of projections of final demand. This problem could be overcome if the transactions table from which the input coefficients are derived can be produced at regular and frequent intervals, with better methods of data collection and, if satisfactory, adjustment can be made to 'out of date' coefficients to allow for such factors as changes in technology and the pattern of trade.[5]

In the short run, however, the previous criticisms of the assumptions embodied in the traditional input-output model, could be defensible. In the short run, there may not be much substitutability between inputs owing to the nature of technology or the comparative stability of relative factor prices. Also, the composition of demand

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[5]A.P. Thirwall, Ibid, p.247

may be assumed to be fairly static in the short run. In addition, the main objective of the study here, is to give some insight and indication as to the directions of effects and broad order of magnitudes rather than to reach any precise set of figures or conclusions. Therefore, the open static input-output model as examined in the next section, has been used in order to examine the linkages and multiplier effects of the petroleum sector in the Egyptian economy.

(5/2/2) The Open Static Input-Output Model

Considering the significance of foreign trade in developing countries, it is important to include imports and exports explicitly in the input-output model. The problem arises here, however, is how to treat imports in the model. Imports can be treated as perfect substitutes and competitive for domestic goods, or they can be treated as different from domestically produced goods and non-competitive and then, treated in the model like a non-produced primary input. However, some countries (such as Egypt) in fact split imports, including both a column of competitive imports and a row of non-competitive imports in the input-output table. For that reason, adjustments have to be made to the previous balance equation to take account of the imported components in determining the proper level of output from the sectoral interdependence system to measure the intersectoral linkages only among domestic productive sectors. For this matter, the inverse matrix net of imports is determined under the following assumptions:

(1) The level of competitive imports is determined outside the system of sectoral interdependence, and they have proportional relationship with gross domestic output.[*] Accordingly, the balance equation can be rewritten as follows:

$$X_i = \Sigma X_{ij} + F_i - M_i$$
$$= \Sigma a_{ij} X_j + F_i - m_i X_i$$

Solving for X,

$$X = (I - A + M)^{-1} F$$

where:

X_i is the vector of gross output of sector i, i=1,2..n

F_i is vector of final demand including exports

X_{ij} is gross sales (domestic and imported) of sector i to sector j

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[*] This is comparable with model III in the treatments of imports in input-output model developed by Matuszewski & others which has been adopted in determining the Leontief's inverse matrix (when dealing with competitive imports) for the Egyptian input-output table. See, T.I. Matuszewski & others, Alternative Treatments of Imports in Input-Output Models: A Canadian Study, (Journal of the Royal Statistical Society, Series A, 126, 1963), pp.417-19.

a_{ij} is input coefficient

m_i is competitive import ratio (ratio of imports to domestic production fixed by sectors), i.e. $m_i = \frac{M_i}{X_i}$

M_i is competitive import vector

I is identity matrix

A is n x n input coefficients matrix

M is a diagonal matrix of import ratios.

(2) non-competitive imports are assumed to be charged directly to the consuming industries but it is assumed that each imported product is distributed to these industries in the same proportions as the corresponding domestic output[7] In mathematical notation:

$$b_{ij} = \frac{X_{ij}^{M}}{X_j} \ ; \text{ and } X_{ij}^{M} = \frac{M_{iN}}{X_i} \times X_{ij}$$

where,

b_{ij} is non-competitive import input coefficient

M_{iN} non-competitive imports of commodity i

X_{ij}^{M} non-competitive imports of commodity i uses as input by industry j

when $i = j$ b_{ij} = Zero

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[7] This hypothesis is close to that of C.P. Modlin & G. Rasenbluth in their treatment of imports in the input-output model. See: C.P. Modlin & G. Rasenbluth, The Treatment of Foreign & Domestic Trade and Transportation in the Leontief Input-Output Table, In O. Morgenston (ed.), Economic Activity Analysis, (John Wiley & Sons, INC, New York, 1954), pp.129-73.

Thus, the input of domestically produced i into industry j must be equal to the total supply of i used by j less the imported part, i.e.

$$Y_{ij} = X_{ij} - X_{ij}^{M} = a_{ij}\ X_j - b_{ij}\ X_j$$

$$= (a_{ij} - b_{ij})\ X_j$$

$$= a^*_{ij}\ X_j$$

According to the above two assumptions, the final form of the new balance equation can be as follows:

$$X_i = Y_{ij} + F_i - M_i$$

$$X_i = (X_{ij} - X_{ij}^{M}) + F_i - M_i$$

$$X_i = (a_{ij} - b_{ij})\ X_i + F_i - m_i\ X_i$$

Thus, the following system of simultaneous equations can be written,

$$X_1 = a_{11}X_1 + (a_{12} - b_{12})X_2 + .. + (a_{1n} - b_{1n})X_n + F_1 - m_1\ X_1$$

$$X_2 = (a_{21} - b_{21})X_1 + a_{22}X_2 + .. + (a_{2n} - b_{2n})X_n + F_2 - m_2X_2$$

$$\begin{array}{ccc} . & . & . \\ . & . & . \\ . & . & . \end{array}$$

$$X_n = (a_{n1} - b_{n1})X_1 + (a_{n2} - b_{n2})X_2 + .. + a_{nn}X_n + F_n - m_nX_n$$

Transferring all the X's to the left hand side the following new set of simultaneous equations can be obtained

$$(1-a_{11}+m_1)X_1-(a_{12}-b_{12})X_2-..-(a_{1n}-b_{1n})X_n = F_1$$

$$-(a_{21}-b_{21})X_1+(1-a_{22}+m_2)X_2-..-(a_{2n}-b_{2n})X_n = F_2$$

$$\begin{matrix} . & & . & & . \\ . & & . & & . \end{matrix}$$

$$-(a_{n1}-b_{n1})X_1-(a_{n2}-b_{n2})X_2-..-+(1-a_{nn}+m_n)X_n = F_n$$

The above system can be written in matrix form as follows

$$\begin{bmatrix} (1-a_{11}+m_1) & -(a_{12}-b_{12}) & \ldots-(a_{1n}-b_{1n}) \\ -(a_{21}-b_{21}) & +(1-a_{22}+m_2) & ..-(a_{2n}-b_{2n}) \\ . & & . \\ . & & . \\ -(a_{n1}-b_{n1}) & -(a_{n2}-b_{n2}) & ..+(1-a_{nn}+m_n) \end{bmatrix} \begin{bmatrix} X_1 \\ X_2 \\ . \\ . \\ X_n \end{bmatrix} = \begin{bmatrix} F_1 \\ F_2 \\ . \\ . \\ F_n \end{bmatrix}$$

In a short form:

$$[I - (A - B) + M]\ X = F$$

$$[I - A^* + M]\ X = F$$

Solving for X

$$X = [I - A^* + M]^{-1}\ F$$

where:

I is identity matrix

A is n x n input coefficients matrix

B is n x n input coefficients matrix for non-competitive imports in which diagonal elements equal to zero

M is a diagonal matrix of competitive import ratios
$A^* = A - B$

(5/3) The linkage effects:

This section aims at examining the linkage effects of the Egyptian petroleum industry. In other words, it attempts to investigate empirically the degree of interdependence of the oil sector with the rest of the economy. In order to do so, the study has utilized Rasmussen's method [9] for the following reasons: (i) by using the inverse of an input-output matrix, this method takes into account the direct as well as the indirect effects of linkages; (ii) linkage indices according to this method are properly weighted and therefore they are suitable for making inter-industrial comparisons, (iii) it is possible to make inter-industry comparisons between different countries. However, when using this method, the study has been based on different inverse matrices: (1) Leontief input inverse which is based on a matrix of technical input coefficients (i.e. intermediate inputs as a share of total inputs including value added); and (2) the

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[9] N.P. Rasmussen, Studies In Inter-Sectoral Relations, (North-Holland Publishing Company, Amsterdam, 1956), ch.8.

output inverse which is based on technical output coefficients (i.e. intermediate sales as a share of total sales including final demand), in particular when measuring forward linkages.

(5/3/1) Leontief inverse matrix:

According to the input-output model developed in the previous section, the gross output levels X's required to sustain a given vector of final demand F in the model are determined by the following equation:

$$X = (I - A^* + M)^{-1} F$$

Let us denote the elements of Leontief inverse matrix $(I - A^* + M)^{-1}$ by Z_{ij}'s. The sum of the column elements of the

$(I - A^* + M)^{-1}$ ($\sum_{j=1}^{n} Z_{ij} = Z_j$) indicates the total input requirements for a unit increase in the final demand for the j^{th} sector.

In similar way the sum of the raw elements ($\sum_{j=1}^{n} Z_{ij} = Z_i$) indicates the increase in the output of sector number i needed to cope with a unit increase in the final demand of all the industries.

The averages $\frac{1}{n}Z_j$ (where n is the number of the sectors), are interpreted by Rasmussen as an estimate of the direct and indirect increase in output to be supplied by an industry chosen at random if final demand for the products of industry number j (j=1,...,n) increases by one unit.[10]

Also the averages $\frac{1}{n} Z_i$ (i = 1,..,n) are interpreted by Rasmussen as an estimate of the increase in output to be supplied by industry i if the final demand for the products of an industry chosen at random is increased by one unit.

To make inter-industry comparisons, the above averages are normalized by the overall average defined as:

$$\frac{1}{n^2} \sum_{j=1}^{n} \sum_{i=1}^{n} Z_{ij} = \frac{1}{n^2} \sum_{j=1}^{n} Z_j = \frac{1}{n^2} \sum_{i=1}^{n} Z_i$$

Accordingly, the following indices are considered:

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[10] N.P. Rasmussen, <u>Studies In Inter-Sectoral Relations</u>, <u>op.cit.</u>, p.133.

$$U_j = \frac{\frac{1}{n} Z_j}{\frac{1}{n^2} \sum_{j=1}^{n} Z_j} \tag{1.4}$$

$$U_i = \frac{\frac{1}{n} Z_i}{\frac{1}{n^2} \sum_{i=1}^{n} Z_i} \tag{2.4}$$

U_j and U_i are termed by Rasmussen as the " index of dispersion" and the index of sensitivity of dispersion". They can also be interpreted as measures of Hirschman's backward and forward linkages.

Thus when $U_j > 1$ indicates that the industry draws heavily on the other industries, and the opposite holds in the case of $U_j < 1$. In a similar way $U_i > 1$ means that industry will have to increase its output more than the other industries to obtain a given increase in final demand from the whole system and vice versa for $U_i < 1$.

The indices U_j and U_i are based on the method of averaging. It is, however, well known from the theory of statistics that averages are sensitive to extreme values and may give misleading results. Consequently the indices U_j and U_i do not fully describe the structure of a particular industry. In order to overcome this difficulty, a measure of variability must be defined and the indices of coefficient of variation are defined as:

$$V_j = \frac{\sqrt{\frac{1}{n-1} \sum_{i=1}^{n} (Z_{ij} - \frac{1}{n} Z_j)^2}}{\frac{1}{n} Z_j} \qquad (3.4)$$

$$V_i = \frac{\sqrt{\frac{1}{n-1} \sum_{j=1}^{n} (Z_{ij} - \frac{1}{n} Z_i)^2}}{\frac{1}{n} Z_i} \qquad (4.4)$$

A high V_j can be interpreted as showing that a particular industry draws heavily on one or a few sectors and a low V_j as an industry drawing evenly from the other sectors. The V_i's can be interpreted similarly.

Accordingly, a key sector can be defined as one in which (a) both U_j and U_i are greater than unity and (b) both V_j and V_i are relatively low.

<u>(5/3/2) The output inverse matrix and forward linkages:</u>

In equation (2.4) ($U_i = \dfrac{\frac{1}{n} Z_i}{\frac{1}{n^2} \sum_{i=1}^{n} Z_i}$)

the numerator refers to the i^{th} row sum of the Leontief inverse which in turn measures the total impact on sector i when final demand for all sectors increases by unity. If this impact is large, it suggests that increased investment in sector i would induce output increases in all using sectors, as users take advantage of the increased availability of inputs. This index might seem to be a good measure of forward linkages. However, it is not. With a large input-output table, a small sector j which relies heavily on sector i for inputs will lead to a biased index of forward linkages for sector i. Since capacity expansion in sector i based on high forward linkages, it might therefore, have a disappointing impact on the overall rate of growth of the economy, because of the small size of using sector j. Thus, the index U_i might be a misleading measure for forward linkages.

To overcome this problem, a new index for forward linkages derived from the output inverse matrix, as distinct from Leontief inverse, has been suggested.[11] Considering an n sector input-output table, the balance equations can be written by summing down the columns as:

$$X^* = X^*C + V^* \qquad (1.a)$$

where:

c is output coefficients matrix

* denotes a row vector

---

[11] See, L.P. Jones, The Measurement of Hirschmanian Linkages, Quarterly Journal of Economics, vol. XC, 1976, pp.323-333, and V Bulmer-Thomas, Input-Output Analysis In Developing Countries, (John Wiley and Sons Ltd, New York, 1982), pp.190-94.

V is a vector whose elements represent value added in each sector.

X is a vector whose elements represent gross output in each sector.

and $C_{ij} = \frac{Y_{ij}}{X_i}$ (2.a)

where

C_{ij} is output coefficient which assumed to be fixed

$Y_{ij} = X_{ij} - X_{ij}^M$ and they are defined as before

Thus, the following system of simultaneous equations can be written,

$$X_1 = C_{11}X_1 + C_{21}X_2 + \ldots + C_{n1}X_n + V_1$$
$$X_2 = C_{12}X_1 + C_{22}X_2 + \ldots + C_{n2}X_n + V_2$$
$$\vdots$$
$$X_n = C_{1n}X_1 + C_{2n}X_2 + \ldots + C_{nn}X_n + V_n$$

Then, the above system can be written in matrix form as fcllows:

$$[X_1, X_2, \ldots, X_n] \begin{bmatrix} (1-C_{11}) & -C_{12} & \ldots & -C_{1n} \\ -C_{21} & (1-C_{22}) & \ldots & -C_{2n} \\ \vdots & & & \\ -C_{n1} & -C_{n2} & \ldots & (1-C_{nn}) \end{bmatrix} = [V_1, V_2, \ldots V_n]$$

In a short form,

$$X^* \ (I - C) = V^*$$

solving for X

$$X^* = V^* \ (I - C)^{-1} \qquad (3.a)$$

where

$(I-C)^{-1}$ is the output inverse matrix.

Equation (3.a) is determined under the assumption that non-competitive imports are charged directly to the consuming industries, and distributed to them in the same proportions as the corresponding domestic output, whereas competitive imports are assumed to be determined outside the system of sectoral interdependence.

Assuming that value added in i^{th} sector increases by unity, because of the assumption of fixed output proportions this will induce forward linkages throughout the economy as using sectors respond to the stimulus, the total increase in output for the whole system is given by the row sum of the C matrix i.e. $\sum_{j=1}^{n} C_{ij}$,

and this is a measure of forward linkages for sector i. When normalized as above, the index becomes:

$$U^*_i = \frac{\frac{1}{n} \sum_{j=1}^{n} C_{ij}}{\frac{1}{n^2} \sum_{i=1}^{n} \sum_{j=1}^{n} C_{ij}} \qquad (5.4)$$

and the coefficient of variation becomes:

$$V^*_i = \frac{\sqrt{\frac{1}{n-1} \sum_{j=1}^{n} \left(C_{ij} - \frac{1}{n} \sum_{j=1}^{n} C_{ij}\right)^2}}{\frac{1}{n} \sum_{j=1}^{n} C_{ij}} \qquad (6.4)$$

This new measure of forward linkages (U^*_i) is quite different from the previous one (U_i), because it measures the forward linkages as the increase in output of all using industries rather than as the increase in output of the one supplying industry. It therefore seems to be more in the spirit of the original conception of forward linkages since the basic idea of these linkages is to trace the output increases which occur or might occur in using industries when there is a change in the sector supplying their inputs.

(5/3/3) The results:

1. The Backward Linkages:

Using the data given in Tables (5.1) and (5.2) which represent the Leontief inverse matrices of 1977 and 1979[12], the backward linkage indices (U_j's) and the coefficients of variation (V_j's) in the Egyptian economy along with their respective ranks are shown in Table (5.3).

The sectoral backward linkage indices and the coefficients of variation have been obtained by applying equations (1.4) and (3.4) respectively.

Backward linkages can be defined as stimulus to new investments in input-supplying activities. It is the postulate of economic theory that a country could produce locally inputs required in the other sectors of the economy. In the case of the oil industry, this may take the form of setting up new industries to produce some of the machinery, equipments and materials required for the industry's operations or output-diversification of existing industries through increase in investment to produce some of the input requirements of the oil industry.

It can be expected that the backward linkage of the oil industry is relatively low in developing countries at the present time. Since the oil industry requires for its

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[12]In 1977 imports have been divided into competitive and non-competitive, while in 1979 all imports are assumed to be competitive according to the available data.

Table (5.1) The Leontief Inverse Matrix $(I-A^*+M)^{-1}$ of 1977

SECTORS	1	2	3	4	5	6	7	8	9	10
Agriculture	0.96198	0.03321	0.01502	0.28520	0.03028	0.03734	0.00696	0.00778	0.00613	0.00835
Construction	0.00041	1.01102	0.00333	0.00193	0.02121	0.00450	0.00024	0.00240	0.00645	0.00723
Heavy Industry	0.00775	0.09162	1.25578	0.03648	0.01036	0.02974	0.00581	0.02703	0.01855	0.00574
Light Industry	0.00453	0.12203	0.03778	1.17694	0.05297	0.06616	0.02724	0.02975	0.01916	0.01951
Transportation	0.00166	0.01231	0.01666	0.01079	1.01633	0.04287	0.00340	0.00492	0.00544	0.17436
Rest of Economy	0.01121	0.16880	0.06178	0.05276	0.09542	1.06798	0.01648	0.02257	0.07058	0.04890
Suez Canal	0.00002	0.00034	0.00012	0.00011	0.00019	0.00214	1.00003	0.00005	0.00014	0.00010
Oil Production	0.00140	0.01799	0.03053	0.00559	0.01197	0.00628	0.00299	1.00631	0.26057	0.02110
Oil Refining	0.00417	0.01417	0.05282	0.00956	0.04014	0.01932	0.01000	0.01746	0.91219	0.07324
Electricity	0.00038	0.00504	0.02913	0.00598	0.01157	0.00680	0.00240	0.00346	0.00432	1.00253

Source: Input-Output Table of 1977

Table (5.2) The Leontief Inverse Matrix $(I-A^{*}+M)^{-1}$ of 1979

SECTORS	1	2	3	4	5	6	7	8	9	10
Agriculture	1.22603	0.01671	0.02202	0.21209	0.06152	0.10239	0.00324	0.01021	0.01593	0.00813
Construction	0.00036	0.77584	0.00339	0.00177	0.02393	0.00866	0.00016	0.00328	0.01009	0.00539
Heavy Industry	0.00582	0.03549	1.00997	0.02979	0.01222	0.03473	0.00271	0.03935	0.02215	0.00631
Light Industry	0.00954	0.04694	0.03176	0.89456	0.05300	0.11354	0.01088	0.03137	0.02454	0.01283
Transportation	0.00131	0.00536	0.01030	0.00739	0.93558	0.05540	0.00158	0.00462	0.00862	0.02037
Rest of Economy	0.01230	0.07887	0.07777	0.05497	0.13758	1.10038	0.00933	0.03555	0.14490	0.06337
Suez Canal	0.00002	0.00010	0.00019	0.00022	0.01713	0.00103	1.00003	0.00009	0.00016	0.00037
Oil Production	0.00065	0.00448	0.01790	0.00278	0.00661	0.00313	0.00065	0.99337	0.12123	0.01148
Oil Refining	0.00375	0.00532	0.04838	0.00737	0.04575	0.01686	0.00440	0.02020	0.88335	0.08301
Electricity	0.00028	0.00395	0.01895	0.00398	0.01010	0.00837	0.00129	0.00337	0.00491	1.11789

Source: Input-Output Table of 1979

operations sophisticated machinery, equipment and installation which their local production is presently not possible in such countries.

Table (5.3) reveals that oil production sector had relatively low value of backward linkage index which implies that this sector depends relatively little upon the domestic productive sectors in obtaining its inputs. The low backward linkage index of this sector was likely due to the capital intensive nature of its operations and which require sophisticated machinery, equipment and installations which in turn had been largely imported and not supplied by the domestic productive sectors in the Egyptian Economy.

However, Table (5.3) shows that the backward linkage index of oil production sector relatively increased in 1979 compared to that in 1977. This means that oil production sector drew relatively more from the domestic sectors in 1979 than in 1977. As shown before, oil production sector's share in total domestic intermediate expenses (Table (5.4), increased from 0.5% in 1977 to 3.3% in 1979.

With respect to the oil refining sector, Table (5.3) shows that the backward linkage index of the oil refining sector is relatively high in 1977 and in 1979. Although it can be argued that in 1977, the index should not be taken by itself to indicate a high interdependence of this sector with the rest of the economy, since a large percentage of its intermediate inputs were drawn from the petroleum

Table (5.3) Backward Linkage Indices
and Coefficients of Variation and Their Ranks :
Based on Leontief Inverse Matrix

SECTORS	1977			1979		
	Uj	Vj	RANK	Uj	Vj	RANK
Agriculture	0.764	3.05	10	1.035	3.07	4
Construction	1.137	2.092	3	0.799	2.467	10
Heavy Industry	1.157	2.588	2	1.109	2.514	5
Light Industry	1.22	2.322	1	0.998	2.296	7
Transportation	0.993	2.426	6	1.07	2.195	3
Rest of Economy	0.987	2.58	7	1.186	2.34	1
Suez Canal	0.828	2.918	9	0.849	3.046	9
Oil Production	0.864	2.8	8	0.937	2.71	8
Oil Refining	1.004	2.193	5	1.015	2.2	6
Electricity	1.05	2.27	4	1.091	2.611	2

Table (5.4) Contribution to Intermediate Expenses

(value in millions LE)

SECTORS	1977		1979	
	VALUE	%	VALUE	%
Agriculture	533.69	12	910.045	13
Construction	493.85	11	383.1	5.5
Heavy Industry	296.79	6.65	427.223	6
Light Industry	1949.32	43.7	2278.087	32.4
Transportation	117.85	2.6	261.442	3.7
Rest of Economy	877.8	19.7	2251.998	32
Suez Canal	9.57	0.2	11	0.2
Oil Production	22.97	0.5	231.152	3.3
Oil Refining	147.64	3.31	254.309	3.6
Electricity	15.4	0.34	20.144	0.3
Total	4464.88	100	7028.5	100

Source : 1977 and 1979 input-output tables

sector itself in 1977 (Table (5.5) shows that 69.7% of oil refining sector's intermediate inputs comes from oil production sector and 8.76% from its own sector in 1977).

However a comparison between the backward linkage indices in 1977 and 1979 of oil refining sector, indicates that the index slightly increased from 1.004 in 1977 to 1.015 in 1979. This implies that the oil refining sector increased its reliance on inputs from other sectors of the economy. At the same time, it diversified the nature of its dependence on inputs from the other sectors in the Egyptian economy. It increased its purchases from the non-oil sectors and decreased its purchases from oil production in particular, (Table (5.5) shows that oil refining sector sharply decreased its intermediate purchases from oil production sector from 69.7% in 1977 to 36.5% in 1979). Generally speaking, it can be argued that the backward linkage index of oil refining sector indicates a relatively high interdependence of this sector with the rest of the Egyptian economy in particular in 1979.

2. The Forward Linkages:

Forward linkage indices can be calculated based on two inverse matrices, Leontief inverse and the output inverse matrix. As it has been argued before, it is preferable to calculate forward linkage indices based on the output inverse matrix. In the case of Leontief inverse matrix, the forward linkage index of sector i might be misleading

Table (5.5) Inputs to the Petroleum Sector

(value in millions LE)

SECTORS	1977				1979			
	OIL PROD'N		OIL REFINING		OIL PROD'N		OIL REFINING	
	VALUE	%	VALUE	%	VALUE	%	VALUE	%
Agriculture	0	0	0	0	0	0	0	0
Construction	0.54	2.35	2.06	1.4	6.4739	2.8	8.403	3.3
Heavy Industry	5.27	22.94	2.86	2	70.4899	30.5	9.1908	3.6
Light Industry	6.36	27.69	2.22	1.5	56.7509	24.6	4.6753	1.83
Transportation	0.71	3.1	0.21	0.14	4.8985	2.1	0.551	0.22
Rest of Economy	4.63	20.16	23.32	15.8	48.3766	20.9	96.0701	37.8
Suez Canal	0	0	0	0	0	0	0	0
Oil Production	0.23	1	102.94	69.7	1.944	0.8	92.817	36.5
Oil Refining	4.55	19.8	12.94	8.76	38.35	16.6	40.4314	15.9
Electricity	0.68	2.96	1.09	0.7	3.8682	1.7	2.1704	0.85
Total	22.97	100	147.64	100	231.152	100	254.309	100

Source : 1977 and 1979 input-output tables

measure for forward linkage when a small sector j relies heavily on sector i. Since capacity expansion in sector i based on high forward linkages, it might therefore have a disappointing impact on the overall rate of growth of the economy, because of the small size of using sector j. Thus the forward linkage index based on output inverse matrix differs from that based on Leontief inverse matrix, since it measures the forward linkages as the increase in output of all using sectors rather than as the increase in output of the one supplying sector. For that reason, forward linkage indices have been measured using the output inverse matrix. Using the data given in Tables (5.6) and 5.7) which represent the output inverse matrices of 1977 and 1979, the sectoral forward linkage indices and the coefficients of variation in the Egyptian economy along with their respective ranks are shown in Table (5.8).

The sectoral forward linkage indices and coefficients of variation have been calculated by applying equations (5.4) and (6.4) respectively.

Forward linkages arise when the output of one industry provides an input for another industry. The Egyptian petroleum industry has potential forward linkages in that it can provide input for the oil refining and the industries which utilize oil as inputs. The establishment of these industries will necessitate new investments which could generate additional income and employment opportunities in the economy.

Table (5.6) The Output Inverse Matrix $(I-C)^{-1}$ of 1977

SECTORS	1	2	3	4	5	6	7	8	9	10
Agriculture	1.26266	0.02748	0.00795	0.66418	0.00973	0.08988	0.00074	0.00153	0.00157	0.00062
Construction	0.00071	1.01110	0.00207	0.00548	0.00757	0.01411	0.00003	0.00048	0.00177	0.00059
Heavy Industry	0.02968	0.16912	1.25541	0.19684	0.00734	0.16439	0.00161	0.00958	0.00980	0.00098
Light Industry	0.00347	0.04424	0.00899	1.20021	0.00731	0.07058	0.00127	0.00260	0.00221	0.00064
Transportation	0.00739	0.03311	0.02694	0.07957	1.01717	0.33532	0.00117	0.00232	0.00379	0.03942
Rest of Economy	0.00224	0.05760	0.01328	0.04956	0.04220	1.06822	0.00075	0.00150	0.00681	0.00143
Suez Canal	0.00009	0.00236	0.00054	0.00203	0.00050	0.04380	1.00003	0.00006	0.00028	0.00006
Oil Production	0.01749	0.10103	0.11117	0.09654	0.02775	0.11427	0.00232	1.00715	0.39787	0.01116
Oil Refining	0.04071	0.06824	0.15691	0.13621	0.07093	0.27040	0.00587	0.01526	1.05562	0.02938
Electricity	0.00820	0.06321	0.21503	0.20553	0.05188	0.22965	0.00368	0.00797	0.01471	1.00262

Source: Input-Output Table of 1977

Table (5.7) The Output Inverse Matrix $(I-C)^{-1}$ of 1979

SECTORS	1	2	3	4	5	6	7	8	9	10
Agriculture	1.28673	0.01575	0.01008	0.41123	0.01874	0.20777	0.00055	0.00790	0.00522	0.00043
Construction	0.00979	1.01735	0.03162	0.08477	0.14048	0.37539	0.00056	0.04416	0.05499	0.00477
Heavy Industry	0.03375	0.13095	1.36474	0.29574	0.02802	0.36099	0.00169	0.11174	0.03267	0.00180
Light Industry	0.01047	0.03316	0.01239	1.21208	0.01704	0.20504	0.00136	0.01757	0.00733	0.00061
Transportation	0.00763	0.02052	0.02025	0.07313	1.02051	0.48455	0.00099	0.01380	0.01132	0.00377
Rest of Economy	0.00926	0.03745	0.02018	0.07151	0.02731	1.18921	0.00077	0.01473	0.02303	0.00167
Suez Canal	0.00028	0.00075	0.00072	0.00377	0.03573	0.01716	1.00004	0.00050	0.00040	0.00013
Oil Production	0.00171	0.00684	0.01402	0.01222	0.00462	0.01599	0.00019	1.00582	0.05255	0.00095
Oil Refining	0.02653	0.02905	0.11596	0.10098	0.07728	0.21771	0.00363	0.07780	1.07459	0.01883
Electricity	0.00977	0.07197	0.16637	0.19373	0.06902	0.39282	0.00376	0.05046	0.03161	1.00139

Source: Input-Output Table of 1979

Table (5.8) Forward Linkage Indices

and Coefficients of Variation and Their Ranks :

Based on Output Inverse Matrix

SECTORS	1977			1979		
	Ui	Vi	RANK	Ui	Vi	RANK
Agriculture	1.321	2.052	1	1.186	2.07	3
Construction	0.667	3.052	10	1.065	1.791	4
Heavy Industry	1.179	2.085	4	1.426	1.76	1
Light Industry	0.857	2.8	7	0.916	2.5	7
Transportation	0.988	2.065	6	0.999	2.02	6
Rest of Economy	0.776	2.747	8	0.842	2.65	8
Suez Canal	0.671	2.999	9	0.64	2.97	10
Oil Production	1.206	1.641	2	0.673	2.822	9
Oil Refining	1.182	1.711	3	1.052	1.851	5
Electricity	1.152	1.683	5	1.202	1.534	2

As shown in Table (5.8), the forward linkage indices of the oil production and oil refining sectors are among the highest in the Egyptian economy in particular in 1977. However, in 1979 these indices declined compared to those in 1977. This might be mainly due to the decreasing intermediate sales of the petroleum sector to the Egyptian economy from 64.6% in 1977 to 58.8% in 1979 of all petroleum sector sales (Table (5.9)).

Table (5.8) shows that in 1977 the forward linkage index of the oil production sector is considerably high compared to the other sectors in the economy, while it sharply dropped in 1979. This event should be analysed further whether it really indicates a high or low interdependence of this sector with the rest of the domestic productive sectors in the Egyptian economy. For this purpose, an investigation of the final disposition of the petroleum sector's output has been made.

Since all production is for the purpose of satisfying final demand, output of all industries would eventually be consumed, invested or exported, directly and/or indirectly. The final disposition of petroleum sector's output is obtained by multiplying the petroleum sector rows in the output inverse matrix by the final demand matrix of the input-output table.

Table (5.10) which presents the final disposition of petroleum sector's output by purchasing sectors and final demand components, reveals the following:

Table (5.9) Intermediate Sales of the Petroleum Sector To the Other Sectors of the Economy (value in millions LE)

SECTORS	1977				1979			
	OIL PROD'N		OIL REFINING		OIL PROD'N		OIL REFINING	
	VALUE	%	VALUE	%	VALUE	%	VALUE	%
Agriculture	0.17	0.12	9.72	4.88	0.1338	0.11	10.5406	3.54
Construction	18.11	12.78	9.66	4.85	8.458	6.85	5.8878	1.98
Heavy Industry	11.26	8	39.32	19.73	10.8924	8.82	49.5865	16.66
Light Industry	8.28	5.8	20.95	10.51	8.058	6.53	27.3017	9.17
Transportation	0	0	22	11.04	0	0	42.0236	14.12
Rest of Economy	0.67	0.47	69.48	34.87	1.1858	0.96	70.3382	23.64
Suez Canal	0	0	1.68	0.84	0	0	1.9311	0.65
Oil Production	0.23	0.16	4.55	2.28	1.944	1.57	38.35	12.88
Oil Refining	102.94	72.67	12.94	6.5	92.817	75.16	40.4314	13.58
Electricity	0	0	8.97	4.5	0	0	11.2659	3.78
Total	141.66	100	199.27	100	123.489	100	297.6	100

Table (5.10) Final Disposition of Petroleum Sectors

Output by Components of Total Demand

(value in millions LE)

COMPONENTS	1977				1979			
	OIL PROD'N		OIL REFIN'G		OIL PROD'		OIL REFIN'G	
	VALUE	%	VALUE	%	VALUE	%	VALUE	%
Intermediate Demand By Petroleum Sector	116.1	7.74	30.3	1.3	103.8	4.8	140.0	4.6
Intermediate Demand By Non-Oil Sectors	375.7	25	671.5	29.2	97.5	4.5	864.6	28.5
Private Consumption	384.4	25.6	701	30.5	77.5	3.6	887.5	29.2
Gov. Consumption	173.8	11.6	384.2	16.7	27.6	1.3	369.2	12.2
Investment	182.4	12.22	211.1	9.2	19.7	0.9	148.1	4.9
Stock Changes	32.2	2.1	43.7	1.9	68.6	3.2	34.5	1.1
Exports	236.2	15.74	257.0	11.2	1767.1	81.7	590.6	19.5
Total Demand	1500.8	100	2298.8	100	2161.8	100	3034.3	100

Source : 1977 and 1979 input-output tables

i) Out of total output of oil production sector 25% was demanded by non-oil sectors in 1977, while this percentage decreased to 4.5% in 1979. Not only that but also out of the total intermediate sales of oil production sector, 23.6% was consumed by the petroleum sector and 76.4% was consumed by the non-oil sectors in 1977. Whereas in 1979, 51.6% of total intermediate output of oil production sector was consumed by petroleum sector and 48.4% by non-oil sectors in the economy.

ii) In 1977 only 15.7% of oil production sector's output was disposed directly for exports, whereas in 1979 more than 80% of the total output of oil production sector was disposed for exports,

iii) With respect to the oil refining sector, three main remarks can be concluded: a) the percentage of intermediate demand by non-oil sectors and of its total output was relatively high in 1977 and 1979 although it slightly declined from 29.2% in 1977 to 28.5% in 1979; b) a relatively high percentage of oil products in both years 1977 and 1979 was consumed by the households; and c) exports of oil products increased from 11.2% in 1977 to 19.5% in 1979 out of the total output of oil refining sector.

In conclusion, the comparison between the 1977 and 1979 reveals that the forward linkage indices of the Egyptian petroleum sector were relatively high when the sector diversified its sales concentrating on the domestic productive sectors in the economy. In other words, the forward linkages of the Egyptian petroleum sector can be expected to increase as the economy is more diversified and this sector has positive impact on domestic productive sectors. This implies that the oil exports would be more in the form of oil products than in the form of crude oil. The high percentage of the sector's output consumed by the households can be mainly attributable to the low domestic prices of oil compared to the international prices (domestic prices of oil in Egypt are about one-fifth of the international prices).[13]

In general, the main contribution of the Egyptian petroleum sector to the economy comes from oil exports. This contribution can then be expected to increase as the exports are more in the form of refined products than in the form of crude oil. This implies a high interdependence of the petroleum sector with the rest of the economy in Egypt. In addition, it can also be expected this contribution to increase by increasing domestic prices of oil in Egypt to be comparable with the international ones. This might lead to decrease the domestic consumption of oil and which in turn means more output is available for export or less depletion of Egyptian oil. However, the crucial

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[13] N. Choucri & S. Lahiri, Short-Run Energy-Economy Interactions in Egypt, (World Development, vol. 12, No. 8, 1984), p.800.

question which might be raised in this case, is what would be the effects of raising domestic oil prices on the other sectors of the Egyptian economy and on petroleum sector's earnings? The answer of this question has been analysed in another place of this research in particular when examining oil pricing policies in Egypt.

(5/5) Multiplier effects:

The Keynesian income multiplier developed in macroeconomic theory indicates the overall total impact of direct and indirect effect on income of one unit increase in final demand. However, such multiplier fails to distinguish between the sectors in which the initial expenditure changes originate. Input-output model, on the other hand, enables us to derive sets of multipliers the main feature of which is that they are disaggregated, recognizing that the total impact on income (output, employment) will vary according to which sector experiences the initial expenditure change.

In this section, the sectoral income multipliers have been estimated to measure the impact of the growth of demand for petroleum industry's output on the Egyptian economy using the input-output analysis. For this purpose, a useful starting point is to distinguish between two types of income multipliers and thereafter their derivation is described.

(5/5/1) Income Multiplier:

There are two common categories of income multipliers in input-output models, and they are considered here. First, there is the so-called Type I multiplier which is based upon direct and indirect results of an exogenous change in final demand when the household is part of final demand and second, there is the so-called Type II multiplier which is based upon the direct, indirect and induced results of an exogenous change in final demand when the household is part of the endogenous system of interdependency and final demand consists of government spending, investment expenditures and foreign purchases.*

(1) Type I Income Multiplier:

This is expressed as the ratio of the direct plus indirect income change to the direct income change resulting from a unit increase in final demand for any given sector. The direct income change for each sector is given by the household row entry of the input-output table when expressed in input coefficient form. The direct and indirect income change is obtained by multiplying each column entry in Leontief inverse matrix by the supplying industry's corresponding household row coefficient and summing the row multiplications.

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* H.W. Richardson, Input-Output & Regional Economics (Weidenfeld & Nicolson, London, 1972), chp.3.

Thus, the direct and indirect income change for sector j is given by

$$a^*_{ij}\ h_i \qquad i = 1,..,\ n$$

where

a^*_{ij} = Leontief inverse matrix coefficient, and

h_i = an entry in the row vector of household coefficient

(2) Type II Income Multiplier:

This is expressed as the ratio of the direct, indirect and induced income change to the direct income change due to a unit increase in final demand . This multiplier differs from the previous one, since it takes into account the repercussionary effects of secondary rounds of consumer spending in addition to the direct and indirect interindustry effects. Income expansion due to successive rounds of consumer spending is derived by expanding the interindustry matrix (A) by inclusion of the household sector endogenous. The direct, indirect and induced income changes per unit of final demand are merely the entries in the household row in the inverse of the new expanded matrix (i.e. households included). The direct income change is exactly the same as in the preceding multiplier.

Accordingly, the new input-output relations where subscript C indicates household and F_i* indicates the remaining final demand components, can be as follows:

$$X_1 = X_{11} + X_{12} + \ldots + X_{1n} + X_{1c} + F_1^*$$

$$X_2 = X_{21} + X_{22} + \ldots + X_{2n} + X_{2c} + F_2^*$$

$$\vdots \qquad \vdots \qquad \vdots \qquad \vdots$$

$$X_n = X_{n1} + X_{n2} + \ldots + X_{nn} + X_{nc} + F_n^*$$

$$X_c = X_{c1} + X_{c2} + \ldots + X_{cn} + X_{cc} + F_c^*$$

In terms of technical coefficients, the above system can be written as follows,

$$X_1 = g_{11}X_1 + g_{12}X_2 + \ldots + g_{1n}X_n + g_{1c}X_c + F_1^*$$

$$X_2 = g_{21}X_1 + g_{22}X_2 + \ldots + g_{2n}X_n + g_{2c}X_c + F_2^*$$

$$\vdots \qquad \vdots \qquad \vdots \qquad \vdots$$

$$X_n = g_{n1}X_1 + g_{n2}X_2 + \ldots + g_{nn}X_n + g_{nc}X_c + F_n^*$$

$$X_c = g_{c1}X_1 + g_{c2}X_2 + \ldots + g_{cn}X_n + g_{cc}X_2 + F_c^*$$

The above system can be written in matrix form as follows,

$$X = GX + F^*$$

$$X - GX = F^*$$

$$(I - G)\ X = F^*$$

$$X = (I - G)^{-1}F^*$$

where

$G = (n+1)(n+1)$ Coefficients matrix of the new input-output system after including households row and column in the system

I = identity matrix

Denoting eij's as elements of the Leontief's inverse matrix net of imports after including household row and column in the system (the inverse matrix here is therefore augmented). Then when there is one unit of final demand for one producing sector (sector 1), and all other final demands are equal to zero, the total output requirements of this producing sector (denoting by vector e), are given by,

$$\begin{bmatrix} X_1 \\ X_2 \\ . \\ . \\ . \\ X_n \\ X_c \end{bmatrix} = \begin{bmatrix} e_{11} & e_{12} & \dots & e_{1n} & e_{1c} \\ e_{21} & e_{22} & \dots & e_{2n} & e_{2c} \\ . & & & . & \\ . & & & . & \\ . & & & . & \\ e_{n1} & e_{n2} & \dots & e_{nn} & e_{nc} \\ e_{c1} & e_{c2} & \dots & e_{cn} & e_{cc} \end{bmatrix} \begin{bmatrix} 1 \\ 0 \\ . \\ . \\ . \\ 0 \\ 0 \end{bmatrix} = \begin{bmatrix} e_{11} \\ e_{21} \\ . \\ . \\ . \\ e_{n1} \\ e_{c1} \end{bmatrix}$$

Where $c = n + 1$

Thus the first column in the inverse matrix $(I - G)^{-1}$ indicates the output required per unit of final demand for output of sector 1. The element e_{c1} indicates the output that household must produce per unit of final demand for output of sector 1. Since the output of household is the income earned by households, e_{c1} indicates the total income generated from one unit increase in final demand for the output of sector 1. It includes not only the direct and indirect income effect but also the induced income effect.

The above explanation of household income multiplier for sector 1 can be generalized for sectoral household income multipliers and written as follows,

$$M_I = \frac{\Sigma\ a^*_{ij}\ h_i}{h_i}, \text{ and } i,j = 1,2,..,n$$

$$M_{II} = \frac{e_{ci}}{h_i}, \quad i = 1,2,..,n$$

where,

M_I = Type I income multiplier,

M_{II} = Type II income multiplier,

a^*_{ij} = Leontief inverse matrix coefficient,

h_i = an entry in the row vector of household coefficient,

e_{ci} = entries in the household row of the inverse matrix $(I - G)^{-1}$

(5/5/2) The Empirical Results:

To evaluate and compare the income impact of final demand changes, income multipliers have been calculated on the basis of the data given in the input-output table of 1977[14]. Using the data given in Table (5.1) which represents the Leontief inverse matrix of 1977, and in Table (5.1$_1$) which represent the inverse of the augmented matrix (I - G), the income interactions in the Egyptian economy are shown in Table (5.12).

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[14] The reason behind using the input-output table of 1977 rather than that of 1979, is that value added in the case of 1977 is divided into two components private and government income which is not available in the case of 1979.

Table (5.11) The Inverse of the Augmented Matrix (I-G)

SECTORS	1	2	3	4	5	6	7	8	9	10	11
Agriculture	1.25336	0.33230	0.15755	0.50635	0.19801	0.32208	0.05859	0.09606	0.08007	0.17622	0.43238
Construction	0.03418	1.04569	0.01985	0.02756	0.04066	0.03750	0.00622	0.01263	0.01502	0.02669	0.05011
Heavy Industry	0.06428	0.14966	1.28344	0.07939	0.04291	0.08499	0.01583	0.04416	0.03290	0.03832	0.08389
Light Industry	0.45872	0.58824	0.25993	1.52166	0.31443	0.50999	0.10771	0.16735	0.13440	0.28118	0.67396
Transportation	0.05476	0.06682	0.04263	0.05110	1.04690	0.09476	0.01281	0.02100	0.01891	0.20495	0.07880
Rest of Economy	0.28083	0.44555	0.19366	0.25739	0.25063	1.33144	0.06425	0.10425	0.13900	0.20424	0.40008
Suez Canal	0.00056	0.00089	0.00039	0.00051	0.00050	0.00266	1.00013	0.00021	0.00028	0.00041	0.00080
Oil Production	0.01009	0.02691	0.03478	0.01219	0.01697	0.01477	0.00453	1.00894	0.26277	0.02611	0.01290
Oil Refining	0.02726	0.03788	0.06411	0.02709	0.05344	0.04189	0.01410	0.02446	0.91805	0.08654	0.03427
Electricity	0.01308	0.01807	0.03534	0.01562	0.01889	0.01922	0.00465	0.00731	0.00754	1.00985	0.01885
Household	1.17938	1.21057	0.57686	0.89510	0.67893	1.15246	0.20896	0.35729	0.28825	0.87947	1.75005

Source: Input-Output Table of 1977

Table (5.12) Income Interactions

In The Egyptian Economy, 1977

Sectors	Direct Income Change	Direct & Indirect Income Change	Indirect Income Change	M_I	Direct & Indirect & Induced Income Change	Induced Income Change	M_{II}
Agriculture	0.689	0.673	-0.016	0.977	1.179	0.506	1.711
Construction	0.514	0.691	0.177	1.347	1.211	0.520	2.357
Heavy Industry	0.201	0.33	0.129	1.642	0.577	0.247	2.87
Light Industry	0.23	0.511	0.281	2.222	0.895	0.384	3.892
Transportation	0.276	0.388	0.112	1.41	0.679	0.291	2.46
Rest of Economy	0.555	0.658	0.103	1.19	1.152	0.494	2.1
Suez Canal	0.095	0.12	0.025	1.263	0.209	0.089	2.2
Oil Production	0.168	0.204	0.036	1.22	0.357	0.153	2.133
Oil Refining	0.076	0.171	0.095	2.24	0.299	0.128	3.921
Electricity	0.288	0.388	0.100	1.35	0.679	0.291	2.259

Where: M_I = Type I income multiplier

M_{II} = Type II income multiplier

Source: Input-output Table of 1977

This table reveals the following:

1) The direct income change is smallest in oil refining sector and highest in agriculture sector. "There are at least four main reasons for differences in the direct income effect. While the relative wage level, labour intensity, and labour productivity have some bearing, perhaps the most decisive factor appears to be the relative importance of imported inputs".[15] Generally, the more highly integrated the sector, the fewer its imports, the larger the share of local inputs and incomes, and the larger the direct income change. In 1977, imported inputs represent 3.6% of agriculture's total output whereas in the case of oil refining sector, imported inputs represent 20.3% of its total output,[16]

2) Both types of income multiplier are highest in the oil refining sector and smallest in the agriculture sector. Generally, high direct income effects go hand in hand with relatively low multipliers and this inverse relationship holds also for all other sectors of the Egyptian economy.

3) Income multipliers of the oil production sector are relatively low compared to those of the oil refining sector. They are however, relatively high compared to those of the other sectors in the economy.

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[15] W.Z. Hirsch, Interindustry Relations of A Metropolitan Area, (Review of Economics & Statistics, 41, 1959), pp.363-4.

[16] Input-Output table of 1977.

4) The different magnitude of the income multipliers between the oil production sector and oil refining sector reflects the differences in their interindustry linkages.

5) Knowledge of the multiplier is sometimes less important than that of the absolute income changes that can accompany an exogenous force of a stated magnitude. in 1977, construction, agriculture and rest of economy sectors had the greatest over-all income impact on the Egyptian economy. A one unit final demand increase raised the economy's income by 1.211, 1.179 and 1.152 unit in those sectors respectively.

Table (5.13) shows the relative importance of the direct, indirect and induced income changes in the Egyptian economy in 1977. This table reveals that the relative importance of these changes varied from one sector to another. The relative importance of direct income changes is smallest for oil refining sector followed by light industry sector.

When the indirect income change is considered, these sectors reverse their order. Agriculture, rest of economy, oil production, Suez Canal, construction and transportation had the smallest relative indirect income effects, while oil refining, light industry and heavy industry had the largest.

The relative importance of induced income changes were constant. This might be partly due to the linear income-consumption function.

Table (5.13) Direct, Indirect and Induced Income Change as Per Cent of Total Income Change in the Egyptian Economy, 1977

Sectors	Direct Income Change	Indirect Income Change	Induced Income Change
Agriculture	0.58	-0.01	0.43
Construction	0.42	0.15	0.43
Heavy Industry	0.35	0.22	0.43
Light Industry	0.26	0.31	0.43
Transportation	0.41	0.16	0.43
Rest of Economy	0.48	0.09	0.43
Suez Canal	0.45	0.12	0.43
Oil Production	0.47	0.1	0.43
Oil Refining	0.25	0.32	0.43
Electricity	0.42	0.15	0.43

Source: Table (5.13)

(5/6) Concluding Remarks:

On the basis of empirical results of the petroleum sector's intersectoral linkages, disposition of its output and the impact multiplier, the following remarks can be concluded.

1) The results show that the Egyptian petroleum sector has positive impact on the economy. Its main contribution to the Egyptian economy comes from its exports. This contribution can be expected to increase as the oil exports are more in the form of refined products than in the form of crude oil. This means that the petroleum sector would increase its interdependence with the rest of the economy.

2) The backward linkages of oil production sector are relatively low and it can be argued that these linkages can be expected not to increase very much in the future because of the capital intensive nature of its operations which need sophisticated machinery and equipments their local production is presently not possible. However, the backward linkages of oil refining sector are relatively high and it can be expected these linkages to increase in the future as the sector expands its capacity and its operations. This implies that the oil refining sector will increase its reliance on the domestic sectors and increase its demand for investments and create more chances for employment.

3) The forward linkages of the Egyptian petroleum sector on the other hand are relatively high and it can be expected to increase as the economy is more diversified and the petroleum sector has positive impact on the domestic sectors. This means not only that the forward linkages of the petroleum sector become more meaningful from economic development point of view, but also means that oil exports are more in the form of refined products than in the form of crude oil.

4) The results also reveal that a high percentage of oil has been consumed domestically. This high percentage is mainly due to the low domestic oil prices in Egypt compared to the international ones. Therefore, it might be better to review the existing domestic pricing policy in Egypt and increase domestic oil prices to be comparable with the world prices taking into consideration the effects of the domestic sectors and on the petroleum sector itself.

5) The results also show that the household income multipliers of oil production sector were relatively high, and these of oil refining sector were the highest in the Egyptian economy.

Chapter 6

The Impact of the Petroleum Industry on the Egyptian Economy. A Macro-Economic Approach

(6/1) Introduction:

The study in the previous chapter has examined the impact of the oil sector on the Egyptian Economy using the input-output approach. Since the macro-economic approach differs from the input-output approach in the sense that the latter contains specific industry groups with particular production functions and then the macro-economic approach provides a complementary method since it enables a statistical test to be made of the impact of a particular sector on the rest of the economy, the study in the present chapter, therefore, aims at assessing the impact of the oil sector on the Egyptian Economy using the macro-economic model. It is mainly to estimate the impact of the petroleum sector's exports on gross national product and its components during 1962-1981. In order to do so, and to shed more light on the mechanism of the economy, a moderate sized and disaggregated macro-econometric model of the type proposed by Klein[1] for the developing economies, is designed for the Egyptian Economy. In this model, foreign

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[1] L.R. Klein, What Kind of Macro-Econometric Model For Developing Economies? In A. Zellner (ed.), Reading In Economic Statistics and Econometrics, (Little Brown & Co., Boston, 1968), pp.559-70, and also L.R. Klein & J. Behrman, Economic Growth Model For the Developing Economy, In W. Eltis & Others (ed.), Induction, Growth & Trade, (Clarendon Press, Oxford, 1970), pp.167-96.

trade is examined in greatest relative detail because of its importance in the open developing economy of Egypt, with special emphasis on exports of primary commodities (oil in particular) and the composition of imports between consumption; investment; raw material, and services imports. Because of the importance of oil as a foreign exchange earner, exports are divided into two major products (oil and non-oil products), and they are considered to be exogenously determined.

<u>(6/2) Specification of the Model and Formulation Experiments:</u>

In analysing the role of the Egyptian petroleum sector in economic development process in Egypt, the present macro-econometric model attempts to describe the functioning of the Egyptian Economy during the period 1962-1981. Thus, the model is based on twenty observations - taking account of the one year lag present in some equations. It contains ten behavioural equations and eight identities. The presence of some lagged variable makes the model dynamic and all equations are linear.

After a number of preliminary tests, the model chosen for this study consists of a set of disaggregated functions which describe economic behaviour in the following spheres: (1) Consumption by households and government, (2) gross capital formation, (3) imports, (4) in addition, the model also incorporates a tax function.

Since the main task is to investigate the impact of oil sector on the economy, oil exports variable has been introduced into all the equations in the model as an explanatory variable, but dropped from the equations where its coefficient was not statistically significant.

<u>(6/2/1) The Statistical Model:</u>

<u>Behavioural Equations:</u>

$$C_p = a_{01} + a_{11}Qd + a_{21}\ x + u_1 \qquad (1)$$

$$C_G = a_{02} + a_{12}T + a_{22}\ C_{G(-1)} + U_2 \qquad (2)$$

$$IA = a_{03} + a_{13}QA + a_{23}IA_{(-1)} + u_3 \qquad (3)$$

$$II = a_{04} + a_{14}QI + a_{24}MI + a_{34}X + U_4 \qquad (4)$$

$$IS = a_{05} + a_{15}QS + a_{25}X + U_5 \qquad (5)$$

$$MC = a_{06} + a_{16}Yd + a_{26}PMC + a_{36}D + U_6 \qquad (6)$$

$$MR = a_{07} + a_{17}QI + a_{27}PMR + a_{37}D + U_7 \qquad (7)$$

$$MI = a_{08} + a_{18}QI + a_{28}PMI + a_{38}D + U_8 \qquad (8)$$

$$MS = a_{09} + a_{19}Yd + a_{29}PMS + a_{39}POP + U_9 \qquad (9)$$

$$T = a_{010} + a_{110}Y + a_{210}M + U_{10} \qquad (10)$$

<u>Identities:</u>

$$C = C_p + C_G \qquad (11)$$

$$I = IA + II + IS + K \qquad (12)$$

$$M = MC + MR + MI + MS \qquad (13)$$

$$Q = Y - X \qquad (14)$$

$$Qd = Q - T \qquad (15)$$

$$Yd = Y - T \qquad (16)$$

$$N = E + X \qquad (17)$$

$$Y = C + I + N - M \qquad (18)$$

where:

<u>(1) Endogenous Variables:</u>

C_P = private consumption

C_G = government consumption

IA = fixed capital formation in agriculture

II = fixed capital formation in industry

IS = fixed capital formation in services

MC = consumption imports

MR = raw materials imports

MI = investment imports

MS = services imports

T = total taxes

Y = gross national product

Q = gross national product net of oil exports

Qd = disposable income net of oil exports

Yd = disposable income

<u>(2) Predetermined Variables:</u>

K = increase in stocks

X = oil exports

E = non-oil exports

$C_{G(-1)}$ = government consumption lagged one year

QA = value added in agriculture

QI = value added in industry

QS = value added in services

$IA_{(-1)}$ = fixed capital in agriculture lagged one year

PMC = relative price index for consumption imports (1975 = 100)

PMI = relative price index for investment imports (1975=100)

PMR = relative price index for raw material imports (1975 = 100)

PMS = relative price index for services imports (1975=100)

POP = number of population (in millions)

D = dummy variable takes the value of one for the period 1968-1973 and zero otherwise to represent the shift in the economy because of 1967 and 1973 wars.

All variables are measured in constant prices (1975=100)

(6/2/2) Consumption Function:

Consumption is disaggregated into private and government consumption. The dependence of consumer expenditures upon the level of disposable income has been well established in both budget surveys and cross-country analysis. It is therefore, assumed in this investigation that private consumption is a linear function of after-tax income. For the purpose of the study oil exports have been separated from the GDP before subtracting the tax. Thus private consumption function becomes a linear function of disposable income net of oil exports plus oil exports.

In examining the behaviour of private consumption expenditure, the relative income hypothesis which suggests that the past level of consumption is an important determinant of current level of consumption has been examined in the following forms:

$$C_p = a_o + a_1 Yd + a_2 C_{p(-1)}$$

and

$$C_p = a_o + a_1 Qd + a_2 X + a_3 C_{p(-1)}$$

where: $C_{p(-1)}$ is private consumption lagged one year.

However, the results of testing this model were not satisfactory in the sense that the regression coefficient of $C_{p(-1)}$ was not statistically significant. This means that the partial adjustment mechanism is not working in the case of Egypt since consumers do not behave in their consumption in a way where the past consumption is related to the present consumption. This can be attributable mainly to the high rate of inflation and the low level of incomes which in turn do not enable consumers to behave affected too much by their habits.

Testing the absolute income hypothesis by omitting the previous level of consumption as an exogenous variable produced satisfactory results which led to the adoption of the following model:

$$C_p = a_{o1} + a_{11} Qd + a_{21} X$$

Government Consumption:

In the case of government consumption, it is assumed that government consumption is a linear function of total taxes and the previous level of government consumption. However, when examining the government consumption function two alternatives were examined:

1. government consumption as a function only of total taxes

   $C_G = a_o + a_1 T$

2. government consumption as a function of total taxes and previous level of government consumption

   $C_G = a_{o2} + a_{12}T + a_{13}C_{G(-1)}$

The results showed that the second estimating equation gave better and satisfactory results and therefore has been adopted. This reflects the fact that government revenue in the case of Egypt, depends mainly on tax revenues. In 1976 and 1981 and the years in between, tax revenues constitute about 92% of total government revenue.[2] Then, it is reasonable to expect that total taxes is one of the main determinants in explaining the government consumption function. It is also reasonable to expect that government behaves in her consumption expenditure in a way where her past consumption is related to the present consumption. Then lagged government consumption is considered to be another main determinant in explaining the function.

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[2] S. Ahmed, Public Finance In Egypt, Its Structure & Trends, (World Bank Staff Working Papers, No. 639, The World Bank, Washington, D.C., USA, 1984), Table 7, p.17.

(6/2/3) Investment Function:

The behaviour pattern of producers in making capital expenditures is represented by three separate investment functions for agriculture, industry and services.

Since the accelerator in its simple form is represented by a certain fixed relationship between capital and output, stated symbolically,

$$\alpha = \frac{I}{Q}$$

where I is capital and Q is output.

When the accelerator translated from a stock to a flow concept, does state that investment is proportional to the change in output i.e. $\Delta I_t = \alpha \Delta Q_t$

However, such simple form of the accelerator has been criticized on the ground that (1) the accelerator is inoperative (or not fully operative) when excess capacity exists. In this case net investment is expected to be positive only when excess capacity was relatively small, (2) there are lags between ordering and actual delivery. Bottlenecks may occur in the production of investment goods, and shortages of key factor resources may occur.[3]

Also this simple accelerator has been criticized empirically on two grounds: (1) relationship of the form $\Delta I_t = \alpha \Delta Q_t + B$ invariably explains very little of investment, and the α's are often not significant,

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[3] J.M. Clark, Business Accelerator & The Law of Demand, (Journal of Political Economy, vol.25, No.1, March, 1917), pp.217-235.

(2) in virtually all empirical studies, the value of α obtained from measuring the average ratio $\frac{I}{Q}$ is much bigger than the value of α obtained from estimating investment functions.[4]

Goodwin and Chenery[5] suggested a stock adjustment model of the form $\Delta I_t = \mu$ (desired I_t - actual I_{t-1}), where μ represents the fraction of the gap between desired and actual stock that is filled at time t. If desired $I=\alpha Q$, then $\Delta I_t = \mu(\alpha Q_t - I_{t-1})$. Here investment is proportional to the level of output, although the basic accelerator ingredient, desired $I = \alpha Q$, is still present. Chenery modified his function slightly by dividing through by I_{t-1} giving,

$$\frac{\Delta I_t}{I_t - 1} = \gamma\left(\frac{\alpha Q_t}{I_t - 1} - 1\right)$$

Chenery interprets $\frac{Q_t}{I_t - 1}$ as a measure of capacity utilization and called this function the capacity principle

The relationship between these various functions (accelerator, stock adjustment, and capacity principle) was presented by Koyck,[6] suggesting that instead of assuming

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[4] M.K. Evans, Macroeconomic Activity, Theory, Forecasting, and Control; An Econometric Approach, (Harper & Row, New York, 1969), p.81.

[5] R.M. Goodwin, The Non-Linear Accelerator & The Persistence of Business Cycles, (Econometrica vol. 19. No.1, Jan. 1951), pp.1-17, H.B. Chenery, Overcapacity & The Accelerator Principle, (Econometrica, vol. 20, No.1, Jan. 1952= pp.1-28.

[6] L.M. Koyck, Distributed Lags & Investment Analysis (Amsterdam: North Holland, 1954).

that $I = \alpha Q_{t-1}$, it is more sensible to determine that capital stock is proportional to some weighted average of previous output which extends over many years. After a certain point, each previous year has a declining weight in this average. There are any number of particular lag structures that could express this fact, Koyck chose a structure with a series of geometrically declining weights. That is, if $0 < \lambda < 1$ then,

$$I_t = \alpha(1-\lambda)(Q_t + \lambda Q_{t-1} + \lambda^2 Q_{t-2} + .. + \lambda^k Q_{t-k} + ..) \quad (1)$$

To simplify, Koyck proposed the following ingenious method of reducing the equation to manageable proportions.

Thus, equation (1) can be rewritten at time t-1 and multiplied by λ, so that

$$\lambda I_{t-1} = \alpha\ (1-\lambda)(\lambda Q_{t-1} + \lambda 2Q_{t-2} + .. + \lambda^k Q_{t-k} + ..) \quad (2)$$

subtracting (2) from (1),

$$I_t - \lambda I_{t-1} = \alpha(1-\lambda)Q_t \quad (3)$$

then,

$$I_t = \alpha\ (1-\lambda)Q_t + \lambda I_{t-1} \quad (4)$$

In general the transformation of an equation $Y_t = \alpha \sum_{i=0} \lambda^i X_{t-i}$ to the form $Y_t = \alpha X_t + \lambda Y_{t-1}$ has become known in the economic literature as a Koyck transformation, and it has been used in estimating the investment functions and some other equations in the model.

To sum up, in the case of investment function, fixed investment is mainly a function of output (measured in value added) and fixed investment lagged one year. However in the case of the Egyptian Economy some other factors beside the above ones, assume importance as follows:

(1) Investment in Agriculture

This category includes besides agriculture also forestry, hunting and fishing. As far as agriculture is concerned, the Egyptian government attempts to stabilize income originating in this sector. It chooses to do so by setting prices most of agricultural products. Thus prices can give an idea on profitability and therefore they could be an explanatory variable for investment in agriculture. However a price variable was tried but dropped, as its coefficient was not statistically significant.

Also another crucial characteristic of Egyptian agriculture that should be accounted for in the explanatory equation, is that as in most of developing countries, most of farmers in Egypt are poor and depend so much on credit that they borrow from the agricultural cooperative banks in Egypt. Therefore such a credit variable should be included in the equation but because of unavailable data, it was dropped.

Therefore the final form of the function which gave satisfactory results is as follows:

$$IA = a_{03} + a_{13}QA + a_{23}IA_{(-1)} + U_3$$

where

IA is fixed capital in agriculture, QA is value added in agriculture and $IA_{(-1)}$ is fixed capital in agriculture lagged one year and U is stochastic term.

(2) Investment in Industry:

This category includes mining, manufacturing, construction and electricity industries. In addition to the main considerations which discussed above in the investment function, foreign capital inflow and interest rate have been tried but dropped as their coefficients were not statistically significant.

Three alternative forms of investment function in industry have been estimated.

a. as a function of output in industry, investment imports and oil exports:

$$II = a_{04} + a_{14}QI + a_{24}MI + a_{34}X = U_4$$

b. as a function of output in industry, previous investment and investment imports:

$$II = a_0 + a_1QI + a_2II_{(-1)} + a_3MI + U$$

c. as a function of output in industry, previous investment and oil exports:

$$II = a_0 + a_1QI + a_2II_{(-1)} + a_3X + U$$

The experiments indicated that investment in industry as a function of output in industry, investment imports and oil exports gave better fit and therefore it has been adopted.

The negative sign of the coefficient of output in industry can be justified on the ground that there is a time gap between investment and obtaining efficient output or between ordering and delivery.

(3) Investment in Service Industries:

This category comprises the rest of the economy. It is expected that output in this sector to be a relevant variable. However this sector seems to be heavily favoured with respect to credits and therefore availability of credit should be included as an explanatory variable. Because of unavailability of data, the velocity of circulation of money as a reflector of the availability of credit was tried but dropped as its coefficient was not statistically significant.

Therefore two alternative forms of investment function in services have been estimated.

a. as a function of output in services and previous investment in services.

$$IS = a_0 + a_1 QS + a_2 IS_{(-1)} + U$$

b. as a function of output in services and oil exports.

$$IS = a_{0s} + a_{1s} QS + a_{2s} X + U_s$$

The experiments showed that the second form gave better fit and therefore has been adopted.

(6/2/4) Import Functions:

Total imports are divided into four main groups: consumption imports, investment imports, raw materials imports, and services imports.

It is generally accepted that income or output variable (measured in value added), and price constitute the main variables explaining variations in imports. The choice of income or output variable depends on the commodity group to be examined. For example, consumption imports may be expected to depend on disposable income, while raw materials may be expected to depend generally on output of industries using them. It is also expected that the estimated coefficient of the income or output to have a positive sign, unless the commodity under consideration is an inferior one, when the income coefficient may be expected to have the negative sign. However, inferior goods are very rare in international trade. Therefore, the income elasticity of demand for imports, in general, is expected to be positive.

The second important variable to be used in explaining the variations in imports is the price of imported goods relative to domestic goods. However, the problem arises here is that import statistics are recorded only by quantity and value without any quoted prices. Therefore, current weighted index numbers of individual import unit values are used as a proxy for import price indices, while the wholesale price index is used as domestic price.

Unit value of imported goods are obtained by dividing value by quantity for each commodity. Then unit value indices on the commodity group level are calculated using Paasche's index number, i.e.

$$\text{Unit value index} = \frac{\Sigma P_{it}\ Q_{it}}{\Sigma P_{ot}\ Q_{it}} \times 100$$

where

P_{it} = unit value in current year

P_{ot} = unit value in the base year

Q_{it} = quantity in current year

Then, the relative price index of imports is obtained by dividing unit value index by the wholesale price index.

In addition to the above explanatory variables, a dummy variable to take account of the break points of the Egyptian economic behaviour since the observations include the period affected by the 1967 and 1973 wars. The dummy variable takes the value of one for the period 1968-1973, and zero otherwise.

In addition, a variable for time trend was introduced as a proxy for some excluded variables like changes in product mix, habits, tastes or technology and tried but dropped as its coefficient was not statistically significant.

(1) Consumption Imports:

Consumption imports include: food and live animal; beverages and tobacco; animal and vegetable oils and fats; manufactured goods classified by raw materials; miscellaneous manufactured articles; commodities and transactions not classified elsewhere.

Consumption imports as a function of disposable income; and the relative price index of consumption imports in addition to the dummy variable to represent the break points of Egyptian economic behaviour because of 1967 and 1973 wars, gave better fit and therefore has been adopted, i.e.

$$MC = a_{06} + a_{16}Yd + a_{26}PMC + a_{36}D + U_{6}$$

where:

MC = consumption imports;

Y_d = disposable income;

PMC = relative price index of consumption imports (1975=100)

D = dummy variable takes the value of one for the period 1968-1973 and zero otherwise to represent the shift in the Egyptian Economy because of 1967 and 1973 wars.

(2) Raw Materials Imports:

This category includes crude materials, inedible, except fuels; mineral fuels, lubricants, related materials; and chemicals as classified in the trade statistics.

This function is relatively simple in the sense that it is logical for such items to be used heavily by the local industries. Therefore, imports of raw materials as function of value added of industry; relative price index of raw materials and a dummy variable to take account for the shift in the economy because of 1967 and 1973 wars, gave better fit and therefore has been adopted, i.e.

$$MR = a_{07} + a_{17}QI + a_{27}PMR + a_{37}D + U_7$$

where:

MR = raw materials imports,

QI = value added of industry,

PMR = relative price index of raw material imports (1975=100),

D = dummy variable represents the shift in the economy.

<u>(3) Investment Imports:</u>

This category comprises machinery and transportation equipment. The experiments showed that investment imports as a function of value added of industry and the relative price index of investment imports in addition to the dummy variable which represents the shift in the economy because of 1967 and 1973 wars gives better fit and therefore has been adopted, i.e.

$$MI = a_{08} + a_{18}QI + a_{28}PMI + a_{38}D + U_8$$

where:

MI = investment imports;

QI = value added in the industry;

PMI = relative price index of investment imports;

D = dummy variable represent the shift in the economy because of 1967 and 1973 wars,

U = stochastic term

(4) Services Imports:

This category includes the rest of imports and the experiments showed that services imports as a function of disposable income, number of the population and the relative price index of services imports gives better fit and therefore it has been adopted. The price index of imports is taken as a proxy for price index of services imports.

$$MS = a_{09} + a_{19}Yd + a_{29}PMS + a_{39}POP$$

(6/2/5) Tax Function:

In the case of Egypt, tax revenues come mainly from tax on business profits, custom duties, consumption tax, stamp taxes, personal income and property taxes. However, business profits tax and custom duties represent the most important two sources for tax revenues. In the period 1976 to 1981, business profits taxes and custom duties constitute the largest source of government tax revenue followed by consumption tax and stamp taxes. Personal income and property taxes are relatively unimportant as sources of tax revenues as shown in the following table:

Table (6.1) Structure of Taxes

(As a Proportion of Total Tax Revenue)[7]

	1976	1977	1978	1979	1980	1981
Business Profit	0.21	0.197	0.25	0.258	0.36	0.337
Personal Income	0.036	0.028	0.024	0.022	0.018	0.018
Property Tax	0.014	0.009	0.011	0.011	0.01	0.008
Consumption Tax	0.214	0.173	0.168	0.223	0.167	0.173
Custom Duties	0.407	0.497	0.428	0.356	0.317	0.336
Stamp Taxes	0.046	0.046	0.059	0.061	0.04	0.051

Source: Ministry of Finance, Cairo

Also the main source of custom duties is the taxes on imports since the taxes levied on exports are only imposed (in a very small percentage) on the exports of a small number of commodities (only raw hides and skins, metal scraps and wastes and antiques).[8]

According to the above investigation, it is reasonable to expect that value added or gross domestic product and imports represent the main determinants in explaining the variation in total taxes. When examining tax function, three alternatives were tried:

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[7] S. Ahmed, Public Finance In Egypt, op. cit., Table 9.

[8] S. Ahmed, Public Finance In Egypt, op. cit., pp.25-27.

1. total taxes as a function of gross domestic product and total imports;

   $T = a_{010} + a_{110}Y + a_{210}M$

2. total taxes as a function of gross domestic product net of exports, total exports and total imports;

   $T = a_0 + a_1(Y - N) + a_2N + a_3M$

3. total taxes as a function of gross domestic product;

   $T = a_0 + a_1Y$

The experiments indicated that the first function gives a much better performance and therefore it has been adopted.

<u>(6/3) Estimation of The Model:</u>

The above model represents a simultaneous equations model, consists of eighteen equations; eighteen endogenous variables, and fourteen predetermined variables. Since the application of ordinary least squares (OLS) to a single equation assumes, among others that the explanatory variables are truly exogenous, that there is one-way causation between the dependent variable and the explanatory variable. If this is not true (which is the case of simultaneous equations system, since there is more than one-way causation between the dependent variables and the explanatory variables), then one of the main assumptions of OLS is violated, since the covariance of independent variable and error term is not zero.[9] In this case the application of OLS yields biased and inconsistent estimates. The solution is then to apply other methods to estimate an equation belonging to a system of simultaneous equations to obtain unbiased and consistent estimates. On the basis of Monte Carlo Studies, two-stage Least Squares (2SLS) seems to be one of the most appropriate methods on the basis of its performance when mis-specification of the equation is present, and on its simplicity of computation.[10]

To test for the identification of each equation to determine the method by which the model can be estimated, formal rules for identification (mainly order condition) have been applied. It states that the equation is identified, if $K-M \geq G-1$, where: G is total number of equations; M is number of variables (endogenous and exogenous) included in the equation; and K is number of total variables in the model. It is obvious that for all equations $K-M > G-1$ and then they all are overidentified. In this case, 2SLS is considered to be the most useful

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9 R.S. Pindyck & D.L. Rubinfeld, Econometric Models & Economic Forecasts, (International Student Edition, McGrow-Hill, 1981), ch.7.

10 A.S. Johnston, Econometric Methods, (McGrow-Hill, 1972), ch.13; A. Koutsoyiannis, Theory of Econometrics, (MacMillan Press Ltd., London, 1977), ch.21; and A.L. Nagar, A Monte Carlo Study of Alternative Simulataneous Equation Estimators, (Econometrica, vol.28, 1960), pp.573-90.

method in estimating overidentified equations.[11] Therefore it has been used in estimating the present model.

(6/3/1) Serial-Correlation in the Presence of Lagged Dependent Variables:

To test for serial-correlation in the presence of lagged dependent variables, the Durbin-Watson statistic (DW) seems to be not useful, because when one or more lagged endogenous variables are present, the DW statistic will often be close to 2 even when the errors are serially correlated. Of course, one could look at the DW statistic as providing an indicator of serial correlation when the DW statistic is low, but this approach is strongly biased against finding serial correlation. The solution is to use another test. This is the Durbin 'h statistic,[12] defined

as, $h = \hat{\rho} \sqrt{\dfrac{N}{1-N[Var(B)]}}$

Where var (B) is estimated as the square of the standard error of the coefficient of the lagged endogenous variable; N is the number of observations, and ρ is the estimated first-order auto-correlation coefficient, i.e.

$$\hat{\rho} = 1 - \frac{DW}{2}$$

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[11] A. Koutsoyiannis, Theory of Econometrics, op. cit., ch.14, 21

[12] R.S. Pindyck & D.L. Rubinfeld, Econometric Models & Economic Forecasts, op.cit., pp.193-95; and J. Durbin, Testing For Serial Correlation in Least Squares Regression when some of the regressors are Lagged Dependent Variable, (Econometrica, vol. 38, May, 1970), pp.410-21

where DW = Durbin Watson statistic

Since Durbin has shown that the h statistic is approximately normally distributed with unit variance, the test for first-order auto-correlation can be done directly by using the normal distribution table. In this case, the null hypothesis there is no auto-correlation. If the value of h is less than the critical value of the normal distribution at a certain level (say 5%), the null hypothesis cannot be rejected and vice versa.

(6/3/2) Sources of the Data:

The basic data required for the analysis come mostly from the U.N. Year Book of National Accounts Statistics, 1978, 1981; IMF, International Financial Statistics, 1983, 1984; IMF, Government Financial Statistics, 1984; The World Bank, World Tables, 1977, 1980, 1983; U.N. International Trade Statistics, 1968, 70, 74, 76, 80, 82; National Bank of Egypt, Economic Bulletin, 1980-1984; Ministry of Planning, Central Agency for Public Mobilization and Statistics, The National Accounts, 1970, 1981; Egyptian Central Bank, Economic Bulletin, 1980-1984 and EGPC, Annual Reports, 1980-83.

They are presented in Appendix (B).

<u>(6/3/3) Solution of the Model:</u>

C_P = 1.91 + 0.73 Qd + 1.08 X
(0.454) (5.3)** (2.29)*

RSS = 107.122 s.e = 2.51 R^2= 0.974 $\bar{R}^2$=0.96
F = 204 D.W = 2.05 Q_1= 5.4

C_G = 0.162 + 0.131T + 0.986 $C_{G(-1)}$
(0.283) (3.51)** (11.37)**

RSS = 6.81 s.e = 0.633 R^2= 0.961 $\bar{R}^2$=0.956
F = 204 D.W = 2.08 standard error of $C_{G(-1)}$=0.086
Durbin'h = -0.194 Q_2 = 3.614

IA = -0.72 + 0.0586 QA + 1.197 $IA_{(-1)}$
(-2.56)* (3.13)** (7.44)**

RSS = 1.02 s.e = 0.245 R^2= 0.785 $\bar{R}^2$= 0.76
F = 30 D.W=1.54 standard error of $IA_{(-1)}$=0.16
Durbin'h = 1.47 Q_3 = 0.619

II = 2.06 - 0.654 QI + 0.622 MI + 0.758X
(3.04)** (- 2.19) * (2.5)* (2.2)*

RSS = 27.7 s.e = 1.31 R^2= 0.83 $\bar{R}^2$= 0.8
F = 26.2 D.W =2.2 Q_4= 1.46

IS = - 3.656 + 0.38 QS + 0.295 X
(-5.01)** (8.12)** (2.77)*

RSS = 7.34 s.e = 0.657 R^2= 0.976 $\bar{R}^2$= 0.974
F = 272 D.W = 1.83 Q_5= 5.11

MC = 2.436 + 0.168 Yd - 1.256 PMC - 2.117 D
(1.074) (7.38)** (-2.11)* (-3.114)*
Rss = 27.96 s.e = 1.32 R^2= 0.887 $\bar{R}^2$=0.865
F = 39 D.W = 1.67 Q_6= 3.155

MR = 2.8 + 0.026 QI - 0.538 PMR - 0.956 D
(5.14)** (2.85)* (-2.67)* (-2.83)*

RSS = 7.06 s.e = 0.664 R^2= 0.68 $\bar{R}^2$= 0.63
F = 11.6 D.W = 1.93 Q_7= 1.526

MI = 5.5 + 0.041 QI - 2.4 PMI - 1.8 D
(5.4)** (3.2)** (-3.7)** (-3.6)**

RSS = 16.7 s.e = 1.02 R^2=0.8 $\bar{R}^2$= 0.77
F = 21.8 D.W = 2.2 Q_8= 4.99

$$MS = -7.5 + 0.0996\ Yd + 0.272\ POP - 4.1\ PMS$$
$$\quad (-3.567)^{**} \quad (3.78)^{**} \quad (2.899)^{*} \quad (-3.57)^{**}$$

RSS = 9.739   s.e = 0.78 $R^2 = 0.912$ $\bar{R}^2 = 0.895$
F = 54   D.W = 2.34 $Q_7 = 3.74$

$$T = -2.69 + 0.2\ Y + 0.177\ M$$
$$\quad (-3.87)^{**} \quad (6.41)^{**} \quad (2.33)^{*}$$

RSS = 14.62   s.e = 0.927 $R^2 = 0.976$ $\bar{R}^2 = 0.973$
F = 417   D.W = 1.41 $Q_{10} = 8.027$

where:

RSS = sum of squared residuals
s.e = standard error of the regression
The Figures in parentheses are t - statistics

** significant at 1% level
 * significant at 5% level

(6/4) Testing of the Model:

To test of the significance of the regression coefficients, t test has been used. The results show that most of the regression coefficients are significant at 1% level and the others at 5% level.

The coefficient of determination R^2 measures the amount of improvement due to the regression line by measuring the reduction in the total sum of squares. It also measures the closeness of fit of the regression line to the observations, and measures the degree of linearity. When R^2 is close to 1, it indicates that the scatter of the observations of the dependent variables is closer to the fit of the regression line and resembles a straight line, and vice versa when R^2 is close to zero. However, the difficulty with R^2 as a measure of goodness of fit is that R^2 pertains to explained and unexplained variation in the dependent variable and therefore does not account for the number of degrees of freedom in the problem. A natural solution is to concern oneself with variances, not variations, thus eliminating the dependence of goodness of fit on the number of independent variables in the model (recall that variance equals variation divided by degrees of freedom). Then using $\bar{R}^2$ or corrected R^2.[13] $\bar{R}^2$ thus has a number of properties which make it a more desirable goodness of fit measure than R^2. When new variables are added to a regression model, R^2 always increases, while $\bar{R}^2$ may rise or fall.[14] Thus the use of $\bar{R}^2$ eliminates at least some of the incentive to include numerous variables in a model without much thought about why they should appear. However, it should not conclude that the corrected R^2 solves all the difficulties associated with using R^2 as a measure of goodness of fit. The decision about whether or not variables should be included in the model should still depend largely upon a priori theoretical considerations. And in any case the numerical value of corrected R^2 will be sensitive to the kind of data being used.

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[13] R.S. Pindyck & D.L. Rubinfeld, Econometric Models & Economic Forecasts, op.cit., pp.79-8.

[14]

$$\bar{R}^2=1-(1-R^2)\,\frac{N-1}{N-K}\quad \text{where:}$$

N = number of observations

K = number of independent variables including the constant

see:

R.S. Pindyck & Rubinfeld, Ibid, p.80

The F statistic has been used to test the overall significance of the regression. In other words, it has been used to test the significance of the R^2 statistic. Strictly speaking, the F statistic with K-1 and N-K degrees of freedom allows to test the hypothesis that none of the explanatory variables helps to explain the variation of the dependent variable about its mean.[15]

The results show that the R^2 and $\bar{R}^2$ statistics are very close in magnitude since there are a large number of degrees of freedom in the model. The results also show that the F statistic is highly significant.

To test for the presence of auto-correlation the Durbin-Watson (DW) statistic has been used. This test assumes values from zero to 4. Tables of critical values of the D.W statistic show that if the calculated disturbance of D.W is less than the lower limit of the D.W statistic, positive auto-correlation is indicated. If the calculated value of D.W is greater than the upper limit of the D.W statistic absence of positive auto-correlation is indicated. If the calculated value is between the lower and upper limits of the critical values of the D.W statistic, the procedure is inconclusive. Whereas in the

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[15] $$F_{K-1,N-K} = \frac{R^2}{1-R^2} \; \frac{N-K}{K-1}$$ where:

K = number of explanatory variables including the constant if the calculated value of F is greater than the tabular value at, say 5% level, the null hypothesis is rejected. This means R^2 is statistically significant and there is linear relationship between dependent and independent variables, and vice versa.

presence of lagged dependent variable as explanatory variable, Durbin h statistic has been used.

Also the auto-correlation functions have been estimated, and Q statistic introduced by Box and Pierce to test the joint hypothesis that all of the auto-correlation coefficients are zero, has been used.[16] Box and Pierce show that the Q statistic is (approximately) distributed as chi square with K degrees of freedom.[17]

The results of all three tests (D.W, Durbin h, and Q statistics) for testing serial independence in the errors showed the absence of auto-correlation of the error term.

(6/4/1) Testing for the Direction of Causality:

In order to test for the direction of causality between some of the variables in the previous model (mainly between output of industry and investment imports, and between investment in industry and investment imports), the bivariate Sims-Granger causality test has been used.[18]

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[16] G.E.P. Box & D.A. Pierce, Distribution of Residual Auto-Correlations in Auto-regressive-Integrated Moving Average Time Series Models, (Journal of the American Statistical Association, vol. 65, Dec. 1970); R.S. Pindyck & D.L. Rubinfeld, Econometric Models & Economic Forecasts , op.cit., ch.16 & 18.

[17] $$Q = N \sum_{K=1}^{K} \hat{\rho}_k^2$$ where: K = number of lags
N = number of observations
$\hat{\rho}$'s = auto-correlation coefficients

If the calculated value of Q is greater than, say, the critical 5% level, it can be 95% sure that the true auto-correlation coefficients are not all zero and then shows the presence of auto-correlation of term and vice versa.

[18] C.A. Sims, Money, Income and Causality, (American Economic Review, 1962) pp. 540-552, and C.W.J. Granger, Investigating Causal Relations by Econometric Models and Cross-Spectral Methods, (Econometrica, vol.37, No.3 July 1969), pp.428-38.

Granger has given a definition of testable kind of causal ordering based on the notion that absence of correlation between past values of one variable X and that part of another variable Y which cannot be predicted from Y's own past implies absence of causal influence from X to Y. More precisely, the time-series Y is said to cause X relative to the universe U (U is a vector time-series including X and Y as components) if, and only if, predictions of $X_{(t)}$ based on $U_{(s)}$ for all s < t are better than predictions based on all components of Us except $Y_{(s)}$ for all s < t. This means that it is possible to talk about causality only when the past causes the present or future since it is impossible for the future to determine or predict the past. Also it will be given content to Granger's definition by assuming X_t and Y_t be stochastic and stationary time series. Thus X can cause Y if, ceteris paribus, past values of X can lead to better prediction of Y.

Granger has confined his attention to unbiased least squares predictions and measures the optimality (the accuracy) of such predictions by the variance (σ^2) of the one-step ahead prediction error. More precisely, let the time series for two variables be X_t and Y_t where the subscript t refers to the time period. It is possible to estimate the following causal models,

$$X_t = a_o + \sum_{i=1}^{K} a_i X_{t-i} + \sum_{i=1}^{K} b_i Y_{t-i} \qquad (1)$$

$$X_t = a_o + \sum_{i=1}^{K} a_i X_{t-i} \qquad (2)$$

$$Y_t = \alpha_o + \sum_{i=1}^{K} \alpha_i Y_{t-i} + \sum_{t-i}^{K} d_i X_{t-i} \qquad (3)$$

$$Y_t = \alpha_o + \sum_{i=1}^{K} \alpha_i Y_{t-i} \qquad (4)$$

S. Ghatak and C. Ayisa have explained the results of the test in a simple manner as follows:

The F-tests[19] are carried out between (1) and (2) and between (3) and (4) with the null hypothesis that (i) $b_i=0$ and (ii) $d_i=0$

The following can occur:

(1) if (i) is rejected and (ii) is accepted, then $Y \rightarrow X$ (i.e. Y causes X);

(2) if (i) is accepted and (ii) is rejected, then $X \rightarrow Y$ (i.e. X causes Y);

(3) if both (i) and (ii) are accepted, then $X \leftarrow / \rightarrow Y$ (i.e. X and Y are independent);

(4) if both (i) and (ii) are rejected, then $X \leftarrow \rightarrow Y$ (i.e. X and Y are interdependent and both cause each other instantaneously).

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[19] $F = \dfrac{(ESS_R - ESS_{UR})/q}{ESS_{UR}/(N-K)}$, where,

ESS_R = error sum of squares of restricted model

ESS_{UR} = error sum of squares of unrestricted model

q = number of restrictions

N = number of observations and K = number of variables including the constant. See: S.Ghatak & C.Ayisa, Stabilization Policies, Money and the role of The International Monetary Fund in Less Developed Countries (LDCs), (Economics Dept., University of Leicester, Discussion Paper No.44) pp.15-16

(6/4/1/1) Results of the Test:

These tests have been carried out on annual data of Egypt between 1964-1981 in particular between output of industry (QI) and investment imports (MI) and between investment in industry (II) and investment imports (MI) and the following results have been obtained:

$$(1)\quad MI = a_0 + \sum_{i=1}^{2} a_i\, MI_{t-i} + \sum_{i=1}^{2} b_i\, QI_{t-i}$$

F = 10.24 (significant at 1%)

$$(2)\quad MI = a_0 + \sum_{i=1}^{2} a_i\, MI_{t-i}$$

$$(3)\quad QI = \alpha_0 + \sum_{i=1}^{2} \alpha_i\, QI_{t-i} + \sum_{i=1}^{2} B_i\, MI_{t-i}$$

F = 7.42 (significant at 1%)

$$(4)\quad QI = \alpha_0 + \sum_{i=1}^{2} \alpha_i\, QI_{t-i}$$

$$(5)\quad II = c_0 + \sum_{i=2}^{2} c_i\, II_{t-i} + \sum_{i=1}^{2} d_i\, MI_{t-i}$$

F = 3.9 (significant at 5%)

$$(6)\quad II = c_0 + \sum_{i=1}^{2} c_i\, II_{t-i}$$

$$(7)\ MI = \gamma_0 + \sum_{i=1}^{2} \gamma_i\ MI_{t-i} + \sum_{i=1}^{2} D_i\ II_{t-i}$$

F = 10.2 (significant at 1%)

$$(8)\ MI = \gamma_0 + \sum_{i=1}^{2} \gamma_i\ MI_{t-i}$$

The results show that the relationships between MI and QI and between II and MI are interdependent and there is instantaneous causality between them.

6/5) Derivation of the Impact Multipliers:

The effect of current changes in certain predetermined or exogenous variables on certain endogenous variables in the economy is known in econometric theory as multiplier analysis. Goldberger[20] formulated the estimation of the impact multipliers from a set of structural equations which is briefly described below.

The general macro-econometric model of linear stochastic nature with m endogenous (jointly dependent) variables Y_1, Y_2, ..., Y_m and n predetermined variables X_1, X_2, ..., X_n can be written as follows:

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[20] A.S. Goldberger, Impact Multipliers & Dynamic Properties of the Klein-Goldberger Model, (Amsterdam: North Holland Publishing Company, 1959), ch.3 An Analyogous approach is given in M. Intrilligator, Econometric Models, Techniques & Applications, (North Holland, Amsterdam, 1978), ch.2.

$$\alpha_{11}Y_1+\alpha_{21}Y_2+\ldots+\alpha_{m1}Y_m+B_{11}X_1+B_{21}X_2+\ldots+B_{n1}X_n= e_1$$

$$\alpha_{12}Y_1+\alpha_{22}Y_2+\ldots+\alpha_{m2}Y_m+B_{12}X_1+B_{22}X_2+\ldots+B_{n2}X_n= e_2$$

$$\vdots$$

$$\alpha_{1m}Y_1+\alpha_{2m}Y_2+\ldots+\alpha_{mm}Y_m+B_{1n}X_1+B_{2n}X_2+\ldots+B_{nn}X_n= e_m$$

where $e_1, e_2, \ldots, e_m$ are m stochastic disturbance terms, the 's are coefficients of endogenous variables, and B's are coefficients of predetermined variables. The system of the above structural equations can also be written in abbreviated vector-matrix notation

$$YA + XB = \varepsilon \tag{1}$$

where,

Y is a row vector of m endogenous variables,

X is a row vector of n predetermined variables,

and ε is a row vector consisting of m additive stochastic disturbance terms.

A and B are matrices of structural coefficients.

If the matrix of endogenous variables coefficients A is non-singular, the structural equation system (1) can be solved for the endogenous variables as functions of all predetermined variables and stochastic disturbance terms. The solution is as follows:

Post multiplying equation (1) by the inverse of A yields

$$YAA^{-1} + XBA^{-1} = \varepsilon A^{-1} \qquad (2)$$

Solving for Y

$$Y = -XBA^{-1} + A^{-1}$$

Denoting $\pi = -BA^{-1}$

$$\hat{U} = \varepsilon A^{-1}$$

Then $Y = X\pi + \hat{U}$ (3)

Equation (3) is the reduced form of the structural equation system written before. In summation form, equation (3) can be expressed as

$$Y_i = \sum_{j=1}^{m} X_j \pi_{ji} + \hat{U}_i \qquad (i=1,2,..,m) \qquad (4)$$

Differentiating equation (4) we obtain

$$\frac{\partial Y_i}{\partial X_j} = \pi_{ji} \qquad \begin{array}{l}(j=1,2,..,n)\\(i=1,2,..,m)\end{array}$$

This result is known as the impact multiplier or short-run multiplier since it indicates the impact of the change in the j-th predetermined variable, with all other predetermined variables being held constant, on the i-th endogenous variable. This multiplier shows the effect of current exogenous variable on current endogenous variable.

The determination of impact multiplier in the structural analysis as given above is analogous to the determination of impact multiplier in input-output model. The coefficients of the endogenous variables correspond with the technical coefficients, and the exogenous variables correspond with the final demand. In terms of the balance equation of the input-output model, the intention discussed in the above structural analysis is equivalent to desiring to know the effect on total output of an exogenous increase in final demand

The regression results of the model which show a good fit and the absence of serial correlation of the stochastic term have been used as the basis for estimating the impact multipliers of various exogenous variables on endogenous variables. Tables (6.2) and 6.3) contain the basic data of constructing the reduced form matrix as shown in table (6.4). The elements of this matrix which appear under each exogenous variable are the impact multipliers which indicate the direct, indirect and induced effect of a change in these variables on various endogenous variables in the model after taking account of their interdependences.

Table (6.4) shows that the impact multipliers generated by the petroleum sector's exports on gross domestic product and its components during the period under study was 0.876 which was greater than that generated by the non-petroleum sectors' exports which was 0.186. The main reason for this as can be seen from this table is that the petroleum sector's exports had a higher effect on consumption, investment, imports and taxes. Although the impact multiplier generated by the petroleum sector's exports on

Table (6.2) Matrix of Endogenous Variables Coefficients

	C_p	C_s	IA	II	IS	MC	MR	MI	MS
C_p	1.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
C_s	0.00000	1.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
IA	0.00000	0.00000	1.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
II	0.00000	0.00000	0.00000	1.00000	0.00000	0.00000	0.00000	-0.62200	0.00000
IS	0.00000	0.00000	0.00000	0.00000	1.00000	0.00000	0.00000	0.00000	0.00000
MC	0.00000	0.00000	0.00000	0.00000	0.00000	1.00000	0.00000	0.00000	0.00000
MR	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	1.00000	0.00000	0.00000
MI	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	1.00000	0.00000
MS	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	1.00000
T	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Y	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Q	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Q_d	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Y_d	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
C	-1.00000	-1.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
I	0.00000	0.00000	-1.00000	-1.00000	-1.00000	0.00000	0.00000	0.00000	0.00000
N	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
M	0.00000	0.00000	0.00000	0.00000	0.00000	-1.00000	-1.00000	-1.00000	-1.00000

	T	Y	Q	Q_d	Y_d	C	I	N	M
C_p	0.00000	0.00000	0.00000	-0.73000	0.00000	0.00000	0.00000	0.00000	0.00000
C_s	0.13100	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
I_A	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
I_I	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
I_S	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
M_C	0.00000	0.00000	0.00000	0.00000	-0.16800	0.00000	0.00000	0.00000	0.00000
M_R	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
M_I	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
M_S	0.00000	0.00000	0.00000	-0.09900	0.00000	0.00000	0.00000	0.00000	0.00000
T	1.00000	-0.20000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.17700
Y	0.00000	1.00000	0.00000	0.00000	0.00000	-1.00000	-1.00000	-1.00000	1.00000
Q	0.00000	-1.00000	1.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Q_d	1.00000	0.00000	-1.00000	1.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Y_d	1.00000	-1.00000	0.00000	0.00000	1.00000	0.00000	0.00000	0.00000	0.00000
C	0.00000	0.00000	0.00000	0.00000	0.00000	1.00000	0.00000	0.00000	0.00000
I	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	1.00000	0.00000	0.00000
N	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	1.00000	0.00000
M	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

Table (6.3) Matrix of Exogenous Variables Coefficients

	Constant	X	E	CG(-1)	QA	QI	QS	IA(-1)	PMC	PMR	PMI	PMS	POP	D	K
C_p	1.91000	1.08000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
C_G	0.01620	0.00000	0.00000	0.98600	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
IA	-0.72000	0.00000	0.00000	0.00000	0.05860	0.00000	0.00000	1.19700	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
II	2.06000	0.75800	0.00000	0.00000	0.00000	-0.65400	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
IS	-3.65600	0.29500	0.00000	0.00000	0.00000	0.00000	0.38000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
MC	2.43600	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-1.25600	0.00000	0.00000	0.00000	0.00000	-2.11700	0.00000
MR	2.80000	0.00000	0.00000	0.00000	0.00000	0.02500	0.00000	0.00000	0.00000	-0.53800	0.00000	0.00000	0.00000	-0.95600	0.00000
MI	5.50000	0.00000	0.00000	0.00000	0.00000	0.04100	0.00000	0.00000	0.00000	0.00000	-2.40000	0.00000	0.00000	-1.80000	0.00000
MS	-7.50000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	-4.10000	0.27200	0.00000	0.00000
T	-2.69000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Y	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Q	0.00000	-1.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Q_d	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Y_d	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
C	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
I	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	1.00000
N	0.00000	1.00000	1.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
M	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

Table (6.4) Reduced Form Matrix

	Constant	X	E	C_g(-1)	QA	QI	QS
C_p	-6.93749	0.62067	-8.67362D-19	-1.36835D-17	-5.08274D-20	-0.18045	-3.29597D-19
C_g	-0.38359	0.06617	0.02431	1.00997	0.00142	-0.02045	0.00924
IA	-0.72000	0.00000	0.00000	0.00000	0.05860	0.00000	0.00000
II	5.48100	0.75800	0.00000	0.00000	0.00000	-0.62850	0.00000
IS	-3.65600	0.29500	0.00000	0.00000	0.00000	0.00000	0.38000
MC	0.39987	0.06229	-9.75782D-19	-3.42087D-18	-5.71808D-20	-0.04153	-3.70797D-19
MR	2.80000	0.00000	0.00000	0.00000	0.00000	0.02500	0.00000
MI	5.50000	0.00000	0.00000	0.00000	0.00000	0.04100	0.00000
MS	-8.69987	-0.06229	-6.50521D-19	0.00000	-3.81205D-20	-0.02447	-2.47198D-19
T	-4.16479	0.50510	0.18557	0.18297	0.01087	-0.15608	0.07052
Y	-16.28464	0.87588	0.18557	0.18297	0.01087	-0.40327	0.07052
Q	-16.28464	-0.12412	0.18557	0.18297	0.01087	-0.40327	0.07052
Qd	-12.11985	-0.62921	-3.46945D-18	0.00000	-2.03310D-19	-0.24719	-1.31839D-18
Yd	-12.11985	0.37079	-3.46945D-18	0.00000	-2.03310D-19	-0.24719	-1.31839D-18
C	-7.32108	0.68684	0.02431	1.00997	0.00142	-0.20090	0.00924
I	1.10500	1.05300	0.00000	0.00000	0.05860	-0.62850	0.38000
N	0.00000	1.00000	1.00000	0.00000	0.00000	0.00000	0.00000
M	10.06856	1.86396	0.83874	0.82700	0.04915	-0.42612	0.31872

	IA(-1)	PMC	PMR	PMI	PMS	POP	D	K
C_p	-1.03823D-18	3.43401	1.47094	6.56180	11.20974	-0.74367	13.32318	-8.67362D-19
C_g	0.02910	0.09834	0.04212	0.15162	0.32101	-0.02130	0.35432	0.02431
IA	1.19700	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
II	0.00000	0.00000	0.00000	-1.49280	0.00000	0.00000	-1.11960	0.00000
IS	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
MC	-1.16801D-18	-0.46571	0.33852	1.51011	2.57978	-0.17115	0.94916	-9.75782D-19
MR	0.00000	0.00000	-0.53800	0.00000	0.00000	0.00000	-0.95600	0.00000
MI	0.00000	0.00000	0.00000	-2.40000	0.00000	0.00000	-1.80000	0.00000
MS	-7.78674D-19	0.46571	0.19948	0.88989	-2.57978	0.17115	1.80684	-6.50521D-19
T	0.22213	0.75069	0.32155	1.15741	2.45049	-0.16257	2.70473	0.18557
Y	0.22213	5.45481	2.33653	10.14618	17.80629	-1.18130	20.95567	0.18557
Q	0.22213	5.45481	2.33653	10.14618	17.80629	-1.18130	20.95567	0.18557
Qd	-4.15293D-18	4.70412	2.01498	8.98876	15.35581	-1.01873	18.25094	-3.46945D-18
Yd	-4.15293D-18	4.70412	2.01498	8.98876	15.35581	-1.01873	18.25094	-3.46945D-18
C	0.02910	3.53235	1.51306	6.71342	11.53075	-0.76497	13.67750	0.02431
I	1.19700	0.00000	0.00000	-1.49280	0.00000	0.00000	-1.11960	1.00000
N	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
M	1.00397	-1.92246	-0.82347	-4.92556	-6.27554	0.41633	-8.39776	0.83874

gross domestic product and its components was higher than that generated by the non-petroleum sectors' exports, it is still relatively low. This might be due to the leakage items of the economy (such as imports).

(6/6) Correlation Analysis:

In order to examine and for more understanding of the impact of the petroleum sector on the Egyptian economy, it is useful to test whether there has been a close correlation between the rate of growth of value added in petroleum sector and that in the rest of the economy. To do so, spearman rank correlation[21] has been used (also product-moment correlation could be used). This test shows whether there has been a positive correlation between these growth rates in view of the fact that the petroleum sector has been the largest contributor to domestic resources as shown in chapter (4).

Table (6.5) shows that there has been positive correlation between the rate of growth of value added in the petroleum sector and that in the rest of the economy. This could reflect the fact that the petroleum sector has been the largest contributor to foreign exchange earnings

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21 $$R = 1 - \frac{6\Sigma D^2}{N(N^2-1)}$$, where:

D = difference between ranks of corresponding pairs of the two variables (either in ascending or descending order, with the mean rank asigned to observations of the same value).
N = number of observation
R = correlation coefficient
The calculation of the correlation coefficients has depended on the data presented in appendix (and which show the annual rates of growth of value added in the oil sector and that in the other sectors of the economy from 1970 to 80.

Table (6.5) Spearman Rank Correlation Coefficients Of the Rates of Growth Of Value Added of Petroleum Sector and Those of Other Sectors

Sectors	Spearman Rank Correlation Coefficent
Agriculture	0.503
Industry[1]	0.515
Services[2]	0.41
The Average of All Non-Oil Sectors	0.476

[1] includes manufacturing, electricity and construction industries.

[2] the rest of the economy.

shortage of which is becoming the main constraint on economic development process in Egypt, as shown in chapter (4). Also the study in chapter (4) has revealed that the petroleum sector has contributed fairly well to investment by attracting massive inflow of foreign capital into the country in addition to its good contribution to the public revenue and to the balance of payments.

Despite the fact that the correlation between the rate of growth of value added in the petroleum sector and that in the rest of the economy, is positive, the correlation coefficients are considered to be relatively low. This might imply that the financial contribution of the oil sector might not have been utilized rationally and/or there are other factors other than oil might have caused the growth in the rest of the economy. In addition, the non-petroleum sectors might have been hindered by some other factors other than the availability of financial resources (e.g. lack of technology and intrepreniourship..etc).

(6/7) Concluding Remarks:

The solution of the proposed macro-economic model indicates that the impact multiplier of the oil sector's exports on gross domestic product is higher than that of the non-oil sectors' exports. Also the estimate shows a higher impact multiplier of the oil sector's exports on disposable income than that of the non-oil sectors' exports. However, the estimates show that the impact multipliers of the oil sector on gross domestic product and disposable income are relatively low. This might be due to the leakage items of the economy (such as imports).

The spearman rank correlation also shows that there is positive correlation between the rate of growth of value added in petroleum sector and those in the other sectors and between the rate of growth of value added in oil sector and that in the rest of the economy as a whole. It can be concluded that according to the examination of the macro impact of the oil sector on the economy, oil sector comes out fairly well as a good leading sector in the Egyptian economy.

Chapter (7)

The Impact of The Egyptian Petroleum Sector on The Egyptian Economy: A Study Of The Demand & Supply Sides

(7/1) Introduction:

The study in the previous chapters has revealed three main facts. First the domestic consumption of petroleum products has increased at a high rate of growth during the period under study, secondly the oil production/reserves ratio is relatively high in Egypt comparing to a country which has a huge amount of reserves, and finally the petroleum sector has contributed fairly well to the Egyptian economy via linkages and multiplier effects during the period under study, in addition to its direct contribution to foreign exchange earnings; to the balance of payments; to investment and to public revenue.

Considering the above three facts taking into consideration the uncertainty of oil discovery as well as the gains in the terms of trade are limited due to the decrease or the slight increase in oil prices. In this case, it can be anticipated not only the impact of petroleum sector to fall but also Egypt can be expected to be a net oil importer in the very near future. The problem then, is not only to what extent oil sector has contributed to the Egyptian economy but also until when this contribution will continue.

Therefore, the present chapter is an investigation of oil demand and oil supply in Egypt to examine to what extent both sides affect the role of oil in the Egyptian economy and hence reach to some policy recommendations in order to enhance and increase the impact of oil sector on the Egyptian economy. For this purpose, oil demand and oil supply models are developed in this chapter in order to determine the main factors affect the demand and supply sides of the petroleum sector in Egypt and which in turn affect its role in the economy.

(7/2) The Demand Side:

Historically, Egypt consumption of oil (mainly petroleum products) has grown at a very rapid rate. During the period 1975-1983, domestic consumption of petroleum products grew at an average rate of 9.6% per year and during the period 1980-1983 grew at an average rate of 11.8% per year (Table (3.10)). This increase in oil consumption due mainly to the very low domestic prices of petroleum products in Egypt comparing to the international level in addition to some other factors such as increases in population and the migration from rural to urban areas and industrial expansion.

Examining the historical trend of domestic oil prices in Egypt, it is not difficult to link domestic oil consumption to its price. Under the present system of oil pricing in Egypt, the pricing of petroleum products is characterized by a great deal of rigidity. Domestic prices of petroleum products (except gasoline) are less than one-third of the international prices and for some products, such as fuel oil, are less than 10% as shown in Table (7.1). Table (7.1) shows also that the total amount of tacit subsidies as a result of the difference between retail price (or domestic price) and world price of petroleum products has increased from 1.5 billion pounds in 1980 to 1.72 and 1.73 billion pounds in 1982 and 1983 respectively. Such increase in the total amount of tacit subsidies is due mainly to the increase in the quantity of petroleum products consumed domestically with fixed retail price. The table also reveals that despite the large increase in domestic consumption of petroleum products in 1983, the total amount of tacit subsidy in 1983 was slightly above the 1982 figure, and this is attributable to the drop in world prices.

Thus domestic oil consumption and domestic price reveal a high correlation. It can then be concluded that low oil prices stimulated demand growth and high prices could do just the opposite. However, such a relationship between demand and price is by no means trivial, and further more, the extent to which demand responds to price can not be easily determined by examining only the historical trends of demand and price. Thus, it is essential to measure quantitively the relative importance of various factors affecting oil demand. From policy point of view, Table (7.1) Petroleum Products Prices and Tacit Subsidies 1980, 1982, 1983

	Quantity 1000 Metric Tonnes			Retail Price LE / Ton			World Price LE / Ton			Change LE / Ton			Retail Prices as % Of World Prices			Subsidy 1000 LE		
	1980	1982	1983	1980	1982	1983	1980	1982	1983	1980	1982	1983	1980	1982	1983	1980	1982	1983
Butagas	382	476	520	52	52	52	214	274.8	267	162	222.8	215	24.3	18.9	19.5	61722	106053	111800
Gasoline Exc.	871	1172	1418	182	210	210	240	225.7	203	58	15.7	7	75.8	93	103	50518	18400	
Gasoline Ordinary	287	261	192	154	154	154	225	214.3	196	72	60.3	42	68.1	71.9	78.6	20664	15738	8064
Naphta	63	69	69	8.5	8.5	8.5	219	200.3	190	210.5	191.8	181.5	3.9	4.2	4.5	13262	13234	12523
Kerosine	1503	1781	1994	37.8	37.8	37.8	228	210.7	176	190.2	172.9	138.2	16.6	17.9	21.5	285871	307935	275571
Gas Oil	2280	3175	3618	36.24	36	36	214	201.6	173	177.76	165.6	137	16.9	17.9	20.8	404404	525780	495666
Fuel Oil	5172	6512	7222	7.5	7.5	7.5	120	113.4	115	112.5	105.9	107.5	6.3	6.6	6.5	583312	689621	776365
Diesel	144	89	75	30.42	30.42	30.42	200	188.4	164	169.58	157.98	133.58	15.2	16.1	18.5	19502	14060	10019
Bitumens	236	299	391	27	27	27	127	120.4	122	100	93.4	95	21.3	22.4	22.1	23400	27927	37145
Total																1462655	1718748	1727153

Source: EGPC, Annual Reports 1980, 1983

understanding the effects of price on demand is particularly important because domestic oil prices to some extent can be affected by policy actions. The purpose of this section hence, is to provide statistical evidence of the demand-price relationship for petroleum products in Egypt and how the demand for petroleum products have responded to alternative levels of prices for the years 1963-1982.

For more understanding of the problem of the demand side in particular the problem of increasing domestic consumption of petroleum products, a useful starting point is to examine the domestic pricing of oil and the system of subsidy in Egypt and its impact on government budget and the balance of payments followed by specification of the demand model for petroleum products and data underlying it; estimation procedure and estimation results; and finally simulation results and policy simulation made with the model for three economic scenarios.

(7/2/1) Domestic Pricing of Oil and the System of Subsidy in Egypt:

"Price controls were introduced in Egypt at the beginning of the Second World War when the economic system was very liberal and almost completely dominated by private enterprise." [1] The balance between supply and demand was achieved largely by quantitative rationing and subsidies. Thus, subsidies were used to redistribute income in favour of low income classes, and to achieve the stability for prices of necessary goods. In other words, they were to achieve the economic and social balance of the economy. This was exactly the starting point of the whole system of petroleum products subsidy in Egypt. Thus, the subsidy system of petroleum products is not a recent government policy but it has a history goes back to the Second World War. Since domestic crude oil was giving large amounts of heavy fuel oil and less gasoline, but both fuel oil and gasoline were enough to satisfy domestic needs. Kerosene was the problem, as the domestic refineries were producing less than the consumption levels of Kerosene when it was the main fuel consumed at that time. The government had to import Kerosene at a very high cost and found it difficult to sell it at high prices to low income classes and hence , she had to subsidize it.[2] The difference however, between the system of subsidy at that time and now, is that the burden of the subsidy did not affect the government budget since it was born to the gasoline prices which was mainly consumed by the high income classes during that

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[1] K. Ikram, Egypt, Economic Management in A Period of Transition, op. cit., p.266.

[2] A Lutfi, The Subsidy System In The Egyptian Petroleum Industry, (Petroleum Magazine, EGPC, Cairo, Jan. . Feb., 1983), pp.5-6.

period. The distribution of Kerosene through the cobone system also guaranteed its fair distribution to low income groups. Thus, the subsidy system did achieve its main goals as mentioned above,during that time and its effect on the economy was not felt before the 1970s. During 1970s, domestic and world inflation increased and world oil prices jumped very quickly and resulted in a general international situation which raised the real cost of subsidy to the Egyptian economy and the price gap appeared clearly as illustrated in Table (7.2). Table (7.2) shows that at the existing level of consumption, the total subsidy implicit in the current prices in 1978 is US $615 millions orabout US $70 a ton.

The questions could be raised now are: Did the subsidy system during the 1970s achieve its main objectives? And to what extent has it affected the Egyptian economy in general and the petroleum sector in particular?

The main objective of the subsidy system is to redistribute income in favour of low income classes through affecting the relative prices of the subsidized goods to assure a minimum standard of living for such classes. A study by US/Aid has revealed that the urban population which represents 45% of the total population in Egypt in 1979, is receiving about 62% of the total energy subsidy, 70% of the

Table (7.2) Petroleum Product Prices, Estimated Costs and Subsidies, 1978[3]

	US Dollars Per Ton						Quantity Marketed (1000 Tons)	Subsidy[b] (millions of US Dollars)
	Pumped Price	Average Refining Cost	Average Transport Cost	Marketing Cost	Price Net of Marketing Cost	International Price[a]		
Butagas	74.88	10.94		40.32	34.56	170	275	37
Gasoline								
Premium	160.7	9.07	0.29	13.1	147.6	150	530	1
Regular	124.56	7.92	0.29	12.1	112.46	140	330	9
Kerosine	16.51	6.05	0.58	8.21	38.3	130	1400	128
Gas Oil	43.49	5.62	0.14	3.91	37.58	120	1457	120
Diesel	35.42	4.61	2.3	6.91	28.51	120	247	14
Fuel Oil	10.8	1.3	0.29	1.73	9.07	75	3998	264
Gas	-	-	-	-	11.5	75	635	40
Total							8772	615

(a) LE1 = US$ 1.44

(b) Based on Sept. 1978 prices

Source: EGPC & World Bank estimates

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[3] K Ikram, Egypt, Economic Management in a Period of Transition, op. cit., p.280.

direct energy subsidy and 55% of indirect subsidy.[4] However, the proportion allocated from the subsidy to the urban population is not equitable and skewed towards higher income levels. Table (7.3) shows that the lowest 27% of the population receives only 16% of the subsidy, while the upper 21% receives 39%. It can be concluded, thus that the subsidy system in Egypt has not achieved its main goal.

The final point is to evaluate the main effects of the subsidy system in the petroleum sector (in particular for petroleum products) on the economy. These effects can be summarized as follows:

1) although the low prices of petroleum products lead the general prices in the production units using such products to be low and competitive compared to the international prices, they on the other hand, encourage wasteful consumption of such products and fast depletion of oil resources;

2) the difference between the domestic prices of petroleum products and the international prices represents an opportunity cost lost for the sector and reduces its contribution to the economy;

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[4] Subsidies in Egypt are divided into three types: 1) direct subsidies, which enable a particular organization to sell specified items at a price that is often well below cost-for example, the payments to the General Authority for supply commodities for the provision of wheat, corn, edible oils, and other commodities; 2) indirect subsidies, which over the operating losses of various organizations-for example, the payments to the Cairo Transportation Authority; 3) hidden subsidies, that is, the opportunities lost because exportable products (for example, raw cotton and petroleum) are sold to other units within the country at less than the world market price. In fact, the first two are similar in that they impose a financial cost which is reflected in the budget; the third imposes a penality through opportunity costs.

Table (7.3) Summary Details of Urban Energy Subsidies as a Share of Estimated Household Expenditures in 1979 (%)

Estimated Urban Household Expenditure 1979	Distribution of Urban Population %	Household Expenditure (LE Mill)	Urban Energy Subsidy as % of Household	Of Which (a) Indirect Subsidy Total %	Total	(b) Direct Subsidy			
						Kerosine	LPG	Electricity	Gasoline
0-778	26.5	23.4	23.4	11.9	11.5	6.9	0.7	2.9	0.9
779-1113	23.7	24	24	12.4	11.6	4.7	1.6	4.1	1.2
1114-1782	28.5	21.6	21.6	11.6	10	2.9	1.8	4	1.3
1783	21.2	20.8	20.8	10.4	10.4	1.1	1.6	3.7	2.3
Total	100	21.9	21.9	11.3	10.7	3.1	1.5	3.7	2.3

Source: Egypts Food & Energy Subsidies in 1979. A Study by US/Aid, 1980

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[4] (continued)

See: K. Ikram, Egypt, Economic Management in a Period of Transition, op. cit. p.327.

3) as a result of the price difference, Egypt is losing the opportunity of using its finite petroleum wealth to mobilize domestic financial resources, the shortage of which is becoming the main constraint on investment. To understand the magnitude of this difference, in 1978 for example, the price of a barrel of crude for domestic consumption in terms of net-back, was US $4 (including excise taxes and other charges), compared with an export price of US $33 a barrel;[5]

4) low prices of petroleum products and increasing domestic consumption mean less amount of oil for export and hence less amount of foreign exchange. Also Table (7.4) shows that the increasing consumption of Gasoline affected the exported quantities of Naphta. As the Gasoline consumption increased from 1275 thousand tons in 1981 to 1610 thousand tons in 1983, the exported quantity of Naphta decreased from 720 thousand tons in 1981 to 588 thousand tons in 1983. The increase in Gas oil consumption from 1973 thousand tons in 1979 to 3618 thousand tons in 1983 led to increase imports of Gas oil from 40 thousand tons in 1979 to 1306 thousand tons in 1983. Also increasing Fuel oil consumption from 5883 thousand tons in 1981 to 7222 thousand tons in 1983 led to decrease Fuel oil exports from 520 thousand tons in 1981 to 421 thousand tons in 1983. It

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[5] The net-back is the wighted average sale price to distributors, less average refining and transportation costs, treasury dues, and excise taxes.

K. Ikram, Egypt, Economic Management in a Period of Transition, op. cit., p.281.

Table (7.4) Domestic Consumption, Exports and Imports of Some Petroleum Products 1979-1983

(1000 Metric Ton)

	Consumption			Exports		Imports
	Gasoline	Gasoil	Fuel Oil	Naphta	Fuel Oil	Gas Oil
1979	1054	1973	4973	686	160	40
1980	1158	2280	5172	717	263	209
1981	1275	2879	5883	720	520	720
1982	1433	3181	6548	675	417	924
1983	1610	3618	7222	588	421	1306

Source: EGPC, Annual Reports, 1980-1983

can be concluded thus, that the subsidy system of petroleum products in Egypt and which led to increasing domestic consumption of such products, has an increasing negative impact on the balance of payments; and finally the burden of subsidies by any mean would affect the government budget and the amount of resources that could be available for financing investment plans.

(7/2/2) Specification of the Demand Model for Petroleum Products

The purpose of the study in this section is to examine the demand for petroleum products in Egypt. Theoretically, this is not the optimal direction for analysis since the demand for petroleum products should be a derived demand from the demand for the activities or processes using them such as transportation, heating, cooking,..etc. But because of this type of data required to estimate the optimal model is not available, direct rather than derived demand function has to be estimated.

When estimating the demand for petroleum products, the following dynamic flow adjustment model, in which demand for petroleum product depends on underlying economic factors (such as price and income), but in which the effects of these factors are spread out over time,[6] has been used. One of the main justifications of using such dynamic model is that it conceptually incorporates the way in which consumers adjust to changes in incomes or prices. As Houthakker and Taylor point out, when comparing static with dynamic type demand models that "probably the most serious defect of the standard approach to demand analysis is its static character, which is not essentially changed

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[6] -P.Balestra & M. Nerlove, Pooling Cross Section & Time Series Data In The Estimation of A Dynamic Model: The Demand For Natural Gas, (Econometrica, vol. 34, No.3, Jul 1966),pp.585-612;
- M. Kennedy, A World Oil Model, In D.W. Jorgenson (ed.), Econometric Studies of US Energy Policy, (North-Holland Publishing Company, Amsterdam, Oxford, 1976),pp.129-131;
- P.K. Verleger, Jr. & D.P. Sheehan, A Study of The Demand For Gasoline, In D.W. Jorgenson (ed.), op.cit., pp.179-234;
- Z Griliches, Distributed Lags: A Survey, (Econometrica, vol.35, No.1, Jan. 1967), pp.16-49

by the arbitrary inclusion of lagged income or prices as predictors. The effect of a change in, say, income is in general neither immediate nor delayed by a year or some other fixed interval, it is more likely to be spread out over some considerable period of time".[7]

In this model, it is assumed that consumers have a desired level of consumption and that they adjust actual consumption to desired consumption over time.

Desired consumption per capita of a given petroleum product at time t (Q^*_t) is made a function of income per capita (Y_t) and price (P_t),

$$Q^*_t = F\ (Y_t,\ P_t) \tag{1}$$

The adjustment between actual and desired consumption, Q_t, is approximated by a linear function

$$Q_t - Q_{t-1} = \gamma\ (Q^*_t - Q_{t-1}) + V_t \tag{2}$$

where V_t is the error term $0 < \gamma < 1$

By making the desired consumption function linear,

$$Q^*_t = C_0 + C_1 Y_t + C_2 P_t + U_t \tag{3}$$

where U_t is the error term

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[7] H. S. Houthakker & L.D. Taylor, Consumer Demand in The US: Analysis and Projections, (Harvard University Press, Cambridge, Massachusetts, 1970), p.9

The consumption equation can be written

$$Q_t - Q_{t-1} = \gamma(C_0 + C_1 Y_t + C_2 P_t + U_t) - \gamma Q_{t-1} + V_t \quad (4)$$

Shifting the lagged term, Q_{t-1}, to the right in (4), the estimating equation can be

$$Q_t = \gamma C_0 + \gamma C_1 Y_t + \gamma C_2 P_t + (1-\gamma) Q_{t-1} + (\gamma U_t + V_t) \quad (5)$$

where $(\gamma U_t + V_t)$ is the new error term

The general consumption function as specified above in (5) and which made petroleum product demand a function of its price, income, and lagged consumption, followed the same approach developed in detail by Houthakker and Taylor.[8] Their model makes consumption per capita a linear function of current and lagged income, prices, and lagged consumption. In particular, they write the function as

$$Q_t = a + b(P_t - P_{t-1}) + CP_{t-1} + d(Y_t - Y_{t-1}) + eY_{t-1} + FQ_{t-1}, \quad (6)$$

Where Q represents quantity, P prices, Y income. All variables are in per capita terms. This is necessary partly because "the underlying theory of consumer choice refers primarily to individuals, and partly because per

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[8] H.S. Houthakker & L.D. Taylor, Ibid, ch.1.

capita relationships are likely to be more meaningful and stable than relationships between aggregates."[9]

Equation (6) can be reduced to a simple specification if it is determined that b = c and d = e,then (6) becomes

$$Q_t = a + bP_t + dY_t + FQ_{t-1} \qquad (7)$$

Houthakker & Taylor distinguish between whether a good is treated as a stock or as a flow, although their basic model concerns the treatment of consumption as a stock. They refer to this model as a "state adjustment" model, stating that the dynamic model expresses the generally accepted idea that current decisions are influenced by past behaviour. It postulates a particular type of relationship between the past and the present. The effect of past behaviour is assumed to be represented entirely by the current values of certain "state variables", of which inventories are a concrete (but not the only) example. The basic dynamic model may therefore be said to represent state adjustment. These state variables themselves are in turn changed by current decisions, and the net result is that of a "distributed lag": current behaviour depends on all past values of the predetermined variables, though more on recent values than on very remote ones.[10]

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[9] H.S. Hauthakker & L.D. Taylor, <u>Ibid</u>, p.29

[10] H.S. Hauthakker & L.D. Taylor, <u>Ibid</u>, pp.9-10

The state adjustment model puts some restrictions on the coefficients b, c, d, and f. In particular, the relationship e = d (b/c) must hold. This restriction complicates the estimation of the state adjustment model because non-linear regression algorithms must be used.[11]

As an alternative to the state adjustment model, a flow adjustment model has been suggested. In this model "the state variables do not appear. Rather than as a process of adjustment in physical or psychological stocks, the dynamics of consumption are viewed as an attempt on the part of consumers to bring their actual consumption closer to some desired level."[12]

Houthakker and Taylor indicate that "an intrinsic advantage of the flow adjustment model is that it can be estimated in double log form as well as in the linear form."[13] Also it allows the dynamization of economic relationship and it allows the estimation of long and short run elasticities of economic variables. Therefore this model has been used in estimating demand for petroleum products in Egypt and which has been developed in this chapter.

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[11] P.K. Verleger, Jr, & D.P. Sheehan, A Study of The Demands For Gasoline, op.cit., p.199.

[12] H.S. Hauthakker & L.D. Taylor, Consumer Demand in The US: Analysis & Projections, op.cit., p.26

[13] Ibid, p.28

(7/2/3) Data Sources and Their Implementation:

The basic data required for the analysis of the demand models for petroleum products in Egypt 1963-1982, come mainly from the Egyptian General Petroleum Corporation (EGPC), Annual and Official Reports; EGPC, Petroleum Magazine, different volumes; The National Bank of Egypt, Economic Bulletin, different volumes; The Egyptian Central Bank, Economic Bulletin, different volumes; Ministry of Planning; The Central Agency for Public Mobilization and Statistics, The National Accounts, 1970, 1981; UN, Year Book of National Accounts Statistics, 1978, 1981; IMF, International Financial Statistics, 1983, 1984; and The World Bank, World Tables, 1968-1982. The data are presented in Appendix (C).

The data used for consumption are time-series values of annual consumption of the main six petroleum products (Gasoline; Liquified Petroleum Gas "LPG", Fuel oil; Kerosene, Gas oil; and Diesel oil) and their aggregate. However, in the calculation reported in this chapter, consumption of petroleum products and income variables are expressed in per capita terms to catch the impact of population variable and its growth on the demand for petroleum products. This is because the underlying theory of consumer choice refers primarily to individuals, in addition per capita relationships are likely to be more meaningful and stable than relationships between aggregates. Although the use of per capita figures on the other hand raises the difficulty that it is not strictly correct to give all persons equal weight irrespective of age and sex, "it has been suggested that equal-weight scales do not produce too much distortion".[14]

However, in economic theory, demand for a product or factor of production is a function of its own price, income and the price of all other goods and services and consumer usually allocates his income depending in part on the relative prices of goods and not on their actual prices. To take account of this, petroleum products prices were deflated by the wholesale price index (WPI). Technically, this means that it is assumed all other prices increase at a uniform rate, the general rate of inflation.

Regarding the price of the aggregate consumption of petroleum products, it was calculated as the weighted average using the shares of the individual products of total consumption as weights for their prices, i.e.

$$P = \sum_{i=1}^{6} S_i P_i \qquad \text{where } i = 1,\ldots,6$$

P = the weighted average price of petroleum products;

S_i = the share of product i in total consumption; and

P_i = the price of product i

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[14] H.S. Hauthakker & L.D. Taylor, Ibid, p.29

(7/2/4) Estimation Procedure:

The estimation of a dynamic demand equation in the presence of a lagged dependent variable is one which has received much attention in the economic literature. The problem is that with ordinary Least Squares method (OLS), it is a well-known result that the presence of auto-correlation in the error term of a model containing a lagged value of the dependent variable as a predictor leads to an inconsistent estimate of the coefficient of the lagged value.[15] This arises because the composite error term of the model is necessarily correlated with the lagged dependent variable, thereby violating one of the basic assumptions of OLS. Therefore, Taylor and Wilson[16] have proposed an estimation procedure known as Three-Pass Least Squares (3PLS) in order to estimate such models. If the model under consideration is as follows:

$$Y_t = aY_{t-1} + BX_t + CX_{t-1} + U_t \qquad (8)$$

where $U_t = dU_{t-1} + \varepsilon_t$ (9)

where ε_t is random,

$E(\varepsilon_t) = 0$

$E(\varepsilon^2_t) = \sigma^2$ for all t

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[15] L. R Klein, The Estimation of Distributed Lags, (Econometrica, vol.26, No.4, 1958), p.554.

[16] L.D. Taylor & T.A. Wilson, Three-Pass Least Squares: A Method For Estimating Models With A Lagged Dependent Variable, (The Review of Economics & Statistics, vol. XLVI, 1964) pp.329-364.

For convenience, Y and X are assumed to be measured from their means so that the intercept disappears. If U_t were a known variable, (8) and (9) could be combined and

$$Y_t = aY_{t-1} + BX_t + CX_{t-1} + dU_{t-1} + \varepsilon_t \qquad (10)$$

could be estimated directly with no problem of inconsistent estimates, but U_t is unknown so that this is not possible. Still it is possible to get an estimate of U_{t-1} which under the conditions that X_t must be non-auto correlated and that X_{t-1} must be excluded from (8), converges stochastically to U_{t-1} and a consistent estimate of "a" can be obtained. It is an interesting result that, if X_{t-1} is included in the model, even when X_t is non-auto correlated, the estimates of "a" and "c" will be inconsistent.[17]

Since most economic data exhibit substantial auto-correlation, it can be concluded that the 3PLS procedure is not very useful in estimating the parameters of the dynamic model as exhibited in (8).[18] Also the 3PLS procedure which entails three steps, depends basically on OLS procedure in estimating the parameters of each step. In addition, in the case of the partial adjustment model as specified in (5), the error term does not involve

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[17] For more discussion, see: L.D. Taylor & T.A. Wilson, Ibid, pp.330-32; and P.J. Dhrymes, Distributed Lags, Problems of Estimation & Formulation, (Holden-Day, INC, SanFrancisco, Oliver & Boyd, Edinburgh, 1971), pp.191-4

[18] P.J. Dhrymes, Ibid, pp.193-4

any autoregressive scheme in the U's and then the error term has no direct connection with its own previous values, so that it can be assumed that the new error term ($\gamma U_t + V_t$) is not auto-correlated.[19]

Therefore, when estimating the demand models of petroleum products in Egypt, OLS procedure has been used and different tests have been used to test for the auto-correlation in the presence of lagged dependent variable such as Durbin "h".[20]

(7/2/5) Empirical Results:

It is noteworthy to mention, at the beginning that although the estimation of the demand model for petroleum products on the micro-levels i.e. sectoral levels, helps to separate out the effects of economic variables (mainly income and price) on each level since the demand of each level or sector would be related to its income and petroleum products prices, however, the lack of data on sectoral level made it difficult to estimate the demand for petroleum products on the micro-level.

Therefore, the demand for petroleum products in Egypt has been estimated only on the macro-level considering petroleum products consumption in the whole economy as one unit. In this respect, the demand for petroleum products

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[19] A. Koutsoyiannis, Theory of Econometrics, (MacMillan Press Ltd, London, 1977), pp.310-311.

[20] See Section (5/3/1)

has been first estimated on aggregate level measuring the consumption of all petroleum products in thousands metric tonnes. When estimating the demand on aggregate level, dynamic as well as static demand models have been estimated. In both cases, a variable for time trend was introduced as a proxy for some excluded variables like changes in technology and tried but dropped as its coefficient was not statistically significant. Also both models either on aggregate or disaggregate (i.e. consumption for each products in the whole economy as one unit) level, have been estimated in both linear and logarithmic forms. However, logarithmic form gave a good result for some of the models and not for the others. Whereas linear form gave a relatively good fit nearly for all cases. Therefore the results of the linear form have been adopted and they have been as follows:

First: On Aggregate Level:

1) The Dynamic Model:.

$$\underset{}{Q} = \underset{(9.9)}{301.3} \; \underset{(-7.97)}{-4.3\,P} + \underset{(6.2)}{0.214\,PGDP} - \underset{(-0.9)}{0.12\,Q_{(-1)}}$$

Se = 9.4 $\bar{R}^2$ = 0.96 F = 147

DW = 2.3 Standard error of $Q_{(-1)}$ = 0.13 Durbin "h"=-0.8

2) The Static Model:

$$Q = \underset{(24.8)}{281.94} \; \underset{(-11.11)}{-4.2\,P} + \underset{(9.53)}{0.162\,PGDP}$$

S.e = 6.9 $\bar{R}^2$ = 0.97 F = 272.7 DW = 1.86

where Q = per capita consumption

P = the price variable

PGDP = per capita GDP

t = Ratios are between parentheses

As the results show, both dynamic and static demand models gave nearly the same results in particular the price and income variables appear very significant giving the right signs as it is expected. The lagged dependent variable ($Q_{(-1)}$) appears insignificant in the case of dynamic model and even gave the wrong sign. This means that the partial adjustment mechanism is not working in the case of aggregate demand for petroleum products in Egypt since the current consumption of petroleum products is not affected by its past. The results also show that the percentage of variation in Q explained by the regressors is very high as shown by $\bar{R}^2$. F-Statistic is also highly significant. DW and Durbin "h" also show the absence of auto-correlation.

Secondly: On Disaggregate Level:

On disaggregate level, demand for petroleum products in Egypt have been estimated for the main six petroleum products consumed in Egypt (i.e. Gasoline, Liquified Petroleum Gas (LPG); Fuel oil; Kerosene; Gas oil and Diesel oil), and the results have been as follows:

(1) Gasoline Consumption:

$$Q_1 = \underset{(3.04)}{13.5} - \underset{(-2.9)}{0.0934}\, P_1 + \underset{(1.82)}{0.00997}\, PGDP + \underset{(5.3)}{0.72}\, Q_{1(-1)}$$

s.e.= 1.1 $\bar{R}^2$ = 0.98 F = 260 DW = 2.15
standard error of $Q_{1(-1)}$ = 0.14 Durbin "h" = -0.43

where Q_1 = per capita Gasoline consumption

P_1 = the relative price of Gasoline

$Q_{1(-1)}$ = lagged per capita Gasoline consumption

The results show the significance of the coefficients of the explanatory variables as t-statistic between parentheses show, giving the right signs as it is expected. Also Durbin "h" show the absence of auto correlation of the error term. $\bar{R}^2$ shows that the variation in Q_1 is highly explained by the variation in the explanatory variables. Also F-statistic is highly significant.

(2) Fuel Oil Consumption:

$$Q_2 = \underset{(1.4)}{60.6} - \underset{(-0.15)}{0.41}\, P_2 + \underset{(3.9)}{0.103}\, PGDP + \underset{(2.2)}{0.42}\, Q_{2(-1)} \underset{(-0.92)}{-1.13}\, TM$$

s.e.= 4.9 $\bar{R}^2$= 0.9 F = 41.7 DW = 1.75
standard error of $Q_{2(-1)}$ = 0.19 Durbin "h"= 1.06

where Q_2 = per capita Fuel oil consumption

$Q_{2(-1)}$ = lagged per capita Fuel consumption

P_2 = relative price of Fuel oil

TM = time trend variable

Fuel oil is mainly consumed in electricity generation and industry. Therefore a ratio of industry value added to GDP was used as explanatory variable but dropped as its coefficient not statistically significant. Also many specifications were experimented to capture the relationship between its consumption and the main economic variables (price and income) and the above specification has been adopted since it gave the best fit in terms of $\bar{R}^2$, F-statistic, Durbin "h" and the right signs of the coefficients of the explanatory variables as it is expected. The results show the significance of the income variable as t-statistic shows. The price variable appears insignificant although it gave the right negative sign as it is expected. Its insignificance can be attributable to its artificial value since it is very highly subsidized. Fuel price also showed little variation if not any over the period of the study or even until 1983. So price response would not be clear when the other factors are considered, in particular the price of Fuel oil is probably a small proportion of total costs, in addition, electricity generation which represents the main consumer of Fuel oil, is geared to demand which presumably was growing, and public sector industries do not adopt a profit criterion and are less sensitive to unit cost changes. The results also show that the variation in Q_2 is reasonably explained by the variation in the explanatory variables as $\bar{R}^2$ shows. Also Durbin "h" show the absence of auto-correlation of the error term.

(3) Liquified Petroleum Gas (LPG) Consumption:

Liquified petroleum Gas is mainly consumed in the residential commercial sector. In the case of LPG, dynamic as well as static models have been estimated. However, the lagged dependent variable $Q_{3(-1)}$ was not statistically significant in the case of the dynamic model. Therefore, the lagged dependent variable was omitted and a static model has been estimated and adopted after introducing the time trend variable (TM), and the results have been as follows:

$$Q_3 = \underset{(2.5)}{3.7} - \underset{(-2.4)}{0.05}\, P_3 + \underset{(5.2)}{0.0081}\, PGDP + \underset{(9.5)}{0.2}\, TM$$

s.e.= 0.2 $\quad \bar{R}^2$= 0.99 $\quad$ F = 1356 $\quad$ DW = 2.3

where Q_3 = per capita LPG consumption

P_3 = relative price of LPG

TM = time trend variable

The results show the significance of the coefficients of the explanatory variables as t-Ratios between parentheses show. $\bar{R}^2$ shows that the variation in Q_3 is very highly explained by the variation in the explanatory variables. F-statistic is highly significant. DW also shows the absence of auto correlation of the error term.

(4) Kerosene Consumption:

$$Q_4 = \underset{(5.9)}{31.11} - \underset{(-5.6)}{0.342} P_4 + \underset{(1.04)}{0.003} PGDP + \underset{(2.75)}{0.34} Q_{4(-1)}$$

s.e = 0.99 $\bar{R}^2 = 0.95$ F = 120 DW = 2.02
standard error of $Q_{4(-1)} = 0.12$ Durbin "h" = 0.053

where Q_4 = per capita Kerosene consumption

P_4 = relative price of Kerosene

$Q_{4(-1)}$ = lagged per capita Kerosene consumption

Kerosene is mainly consumed in the rural areas and which relatively characterised by low income classes. Also as the standard of living improves, people tend to use LPG. In this case, income variable can be expected to have a negative effect on Kerosene consumption if LPG as a substitute is taken into consideration. However, Kerosene consumption experienced a trend of accelerating growth over time. This may be due to the sector's tendency to encourage Kerosene consumption in order to reduce LPG imports which accounts for a significant percentage of petroleum products subsidy. Therefore income variable could be expected to have a positive effect on Kerosene consumption. However, as the results show, income variable although it has the right positive sign as it is expected, appears insignificant. This may be attributable to the subsidy system which affected the price of Kerosene and which in turn affected the performance of the estimation results of Kerosene consumption and/or may be due to that the income variable does not reflect the true income of those classes who consume Kerosene since it was difficult to find data on the part of income earned by these classes or might this be because the demand for Kerosene is highly inelastic to income levels being regarded as necessity. The results on the other hand, show the significance of the coefficients of the rest of the regressors. $\bar{R}^2$ is quite high showing the goodness of fit of the model and F-statistic is also highly significant. DW and Durbin "h" show the absence of auto correlation of the error term.

(5) Gas Oil Consumption:

$$Q_5 = \underset{(2.7)}{8.4} - \underset{(-0.05)}{0.004}\, P_5 + \underset{(4.1)}{0.05}\, PGDP + \underset{(4.4)}{0.583}\, Q_{5(-1)}$$

s.e = 1.4 $\quad \bar{R}^2 = 0.99 \quad$ F = 528 $\quad$ DW = 2.05
standard error of $Q_{5(-1)}$ = 0.13 $\quad$ Durbin "h" = -0.14

where Q_5 = per capita Gas oil consumption

P_5 = relative price of Gas oil

$Q_{5(-1)}$ = lagged per capita Gas oil consumption

Gas oil is mainly consumed in transportation sector. Its consumption increased with the fast growth in the transportation sector under the new liberalized economic policy in Egypt after 1974 and its substitution for Diesel oil. Therefore, the ratio of transportation sector value added to GDP was used as explanatory variable and tried but dropped as its coefficient was not statistically significant. Also a variable of time trend was tried but dropped as its coefficient was not also statistically significant. The results show that price variable appears insignificant although it has the right negative sign as it is expected. Its insignificance may be explained by its artificial value due to the subsidy system. On the other hand, the rest of the explanatory variables appear significant at 1% level as t-Ratios between parentheses, show. $\bar{R}^2$ as a measure of goodness of fit is very high and F-statistic is also highly significant. DW and Durbin "h" show the absence of auto correlation of the error term

(6) Diesel Oil Consumption:

Diesel oil is mainly consumed in the agricultural sector. Its consumption has been steadily declining during the period under study, due to the substitution of Gas oil in new irrigation machines as well as the decline in its use for pumping irrigation water after the completion of the High Dam. In this case, income variable is expected to have a negative sign reflecting the inferiority of Diesel oil because of the existence of its substitutes.

Different specifications were experimented to capture the relationship between Diesel oil consumption and price and income but they were not quite satisfactory. Therefore, the specification which gave bitter fit in terms of R^2, DW, and Durbin "h", has been adopted and the results have been as follows:

$$Q_6 = 1.1 - 0.025\ P_6 - 0.002\ PGDP + 0.92\ Q_{6(-1)}$$
$$(0.96) \quad (-0.95) \quad (-1.2) \quad (12.6)$$

s.e =0.4 $\bar{R}^2 = 0.96$ F = 106.4 DW = 2.04
standard error of $Q_{6(-1)}$ = 0.07 Durbin "h" = -0.094

where Q_6 = per capita Diesel oil consumption

P_6 = relative price of Diesel oil

$Q_{6(-1)}$ = lagged per capita Diesel oil consumption

The results show that the price variable appears insignificant as t-Ratio between parentheses shows although it has the right negative sign as it is expected. This may be due to its artificial value because of the subsidy system. Also income variable has the wrong negative sign as it is expected, indicating that Diesel oil is an inferior good, in agreement with common sense. These results can be explained by the existence of the substitutes such as Gas oil as explained above. However, if farmers have Diesel tractors they are unlikely to change if the relative price of Gas oil becomes more favourable. Surely they are only able to decide to substitute with animal powers. Thus it seems that demand is mainly related to past demand. The results show that $\bar{R}^2$ is very high indicating that the variation in Q_6 is highly explained by the variation in the regressors. Also DW and Durbin "h" show the absence of auto correlation of the error term.

<u>(7/2/6) Price and Income Elasticities:</u>

The demand model as specified in equation (5) and which is in the form:

$$Q_t = C_0\gamma + C_1\gamma Y_t + C_2\gamma P_t + (1-\gamma)Q_{t-1} + U_t$$

Where γ is partial ajustment coefficient and U is error term, has been estimated in a linear form for petroleum products in Egypt and the results were almost as good when measures of goodness of fit were compared (i.e. $\bar{R}^2$ and F-Statistic), as shown in the above section.

In such linear models, price and income elasticities are usually reported at the mean value of P, Y and Q and they are given by.

$$\varepsilon P = \alpha \frac{P}{Q}, \quad \varepsilon_y = B \frac{Y}{Q}, \quad \alpha < 0, \; B > 0$$

Where εP represents the price elasticity, α the estimated price coefficient, P the price variable, Q the quantity variable, ε_y income elasticity, B the estimated income coefficient, and Y the income variable. However, it should be obvious from the above specification of the price and income elasticities that since each elasticity depends upon Q, and Q in turn depends on Y and P, then the change in the elasticity of price is a function of the change in income and the change in the elasticity of income will depend on changes in price. In fact, if

$$Q = \alpha P + BY > 0, \ \alpha < 0, \ B > 0$$

then

$$\frac{\partial \varepsilon P}{\partial Y} = -\alpha B \frac{P}{(\alpha P + By)^2} > 0$$

and

$$\frac{\partial \varepsilon Y}{\partial P} = -\alpha B \frac{Y}{(\alpha P + By)^2} > 0$$

The calculated elasticities in the case of linear demand models as specified before would represent short-run price and income elasticities since the coefficients of price, γC_2, and income, γC_1 include the partial adjustment coefficient, γ , and to calculate the long-run demand elasticities, the adjustments lag must be removed from the equation. To do so, the coefficient of the lagged consumption, $(1-\gamma)$, is first estimated and then the adjustment coefficient is removed and the long-run price and income elasticities are calculated as:

$$\varepsilon_{PL} = \frac{\gamma C_2}{\gamma} \left(\frac{P}{Q}\right) \quad \text{, and}$$

$$\varepsilon_{YL} = \frac{\gamma C_1}{\gamma} \left(\frac{Y}{Q}\right)$$

where

ε_{PL}, and ε_{YL} are long-run price and income elasticities, and they are shown in Table (7.5).

Table (7.5) Price & Income

Elasticities for Petroleum Products

Products	Price Elasticity		Income Elasticity	
	Short Run	Long Run	Short Run	Long Run
Gasoline	-0.59	-2.11	0.098	0.35
Fuel Oil	-0.034	-0.06	0.171	0.294
LPG	-0.53	-0.53	0.29	0.29
Kerosine	-0.75	-1.134	0.036	0.054
Gas Oil	-0.33	-0.8	0.232	0.56
Diesel Oil	-0.12	-1.33	-0.065	-0.72
Aggregate Consumption	-0.503	-0.503	0.134	0.134

Table (7.5) shows that price elasticities for petroleum products are all consistent with economic theory (in terms of the sign). The Table also shows that the price elasticity in the case of Gasoline is relatively high. This, however, seems unrealistic or unreliable, since the high price elasticity means that Gasoline can be highly substituted and this is not very true. This can be attributable to the inaccurate data especially price is atificial due to subsidy system. This in turn affected the performance of the model. On the other hand, it can be argued that the demand for Gasoline is a derived demand from the demand for the activities using it such as transportation and then the high price elasticity could mean that people can substitute small cars for big cars. Also the Table shows that the price elasticity in the case of fuel oil is very low. This may be explained by the artifical value of its price where it is highly subsidized. Also value of its price where it is highly subsidized. Also the price of fuel oil showed little variation if not any, over the period of the study and thus price response would not be clear when the other factors are considered as explained before. On the other hand, Long-Run income elasticities for petroleum products are very low. This is an unexpected result because petroleum products are considered to be superior fuels in Egypt. Since $\bar{R}^2$ for petroleum products models are quite high ranging from 0.9 in the case of Fuel oil to 0.99 in the case of LPG and Gas oil reflecting the goodness of fit of the models, the low elasticities could be attributable to the very low prices of petroleum products in Egypt due to subsidy system and which in turn affected the performance of the models. The income elasticity for Diesel oil gave the wrong negative sign reflecting that Diesel oil is an inferior good because of the existence of substitutes as explained before. On aggregate level, price and income elasticities are quite low although price elasticity is relatively higher, and they are - 0.503 and 0.134 respectively.

In conclusion, at any rate, price elasticities for petroleum products give reasonable evidence for the influence of prices on petroleum products consumption, although the short-run effects are small. Also it can be concluded that the low elasticities mean that petroleum products are necessary goods for the economy. It can be also explained by the very low artificial value of some Fuels prices such as Fuel oil since it is highly subsidized.

Whatever the limitations of the models, especially they are based on annual data with small sample size (twenty observations), the high values of $\bar{R}^2$ and the relatively small standard errors give reasonable satisfaction.

(7/2/7) Models Simulation:

The main purposes of the simulation exercise in this section are to test first for the performance of the models and secondly to simulate the response of the models to a policy change-namely a price policy change. For these purposes, dynamic simulation has been used depending mainly on ex-post simulation (i.e. historical simulation or simulation through the estimation period).

To test for the performance of the model's ex-post simulation, the following measures are used:[21]

(1) a. The Root-mean-Square (rms) error and which is defined as:

$$\text{rms error} = \sqrt{\frac{1}{T} \sum_{t=1}^{T} (Y^s_t - Y^a_t)^2}$$

where

Y^s_t = simulated value of Y_t

Y^a_t = actual value of Y_t

T = number of periods in the simulation

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[21] R.S. Pindyck & D.L. Rubinfeld, Economic Models & Economic Forecasts, op.cit., pp.360-366, and L.R. Klein, An Introduction to Econometrics, (Prentic Hall, 1974), p.242.

The rms error is thus a measure of the deviation of the simulated variable from its actual time path. The magnitude of this error can be evaluated only by comparing it with the average size of the variable in question.

b. The rms percent error, which is defined as:

$$\text{rms percent error} = \sqrt{\frac{1}{T}\sum_{t=1}^{T}\left(\frac{Y^s_t - Y^a_t}{Y^a_t}\right)^2}$$

This is also a measure of the deviation of the simulated variable from its actual time path but in percentage terms.

(2) a. The mean simulation error, which is defined as:

$$\text{Mean error} = \frac{1}{T}\sum_{t=1}^{T}(Y^s_t - Y^a_t)$$

b. The mean percent error, defined as:

$$\text{Mean percent error} = \frac{1}{T}\sum_{t=1}^{T}\frac{Y^s_t - Y^a_t}{Y^a_t}$$

The problem with mean errors is that they may be close to zero if large positive errors cancel out large negative errors, while the rms simulation error would be large. Therefore, the rms simulation error would be a better measure of the simulation performance. This difficulty can be also overcome by using mean absolute errors.

(3) Theil's inequality coefficient, defined as:

$$U = \frac{\sqrt{\frac{1}{T}\sum_{t=1}^{T}(Y^s_t - Y^a_t)^2}}{\sqrt{\frac{1}{T}\sum_{t=1}^{T}(Y^s_t)^2} + \sqrt{\frac{1}{T}\sum_{t=1}^{T}(Y^a_t)^2}}$$

Where the numerator of U is just the rms simulation error, but the scaling of the denominator is such that U will always fall between zero and one. If $U=0$, $Y^s_t = Y^a_t$ for all t and there is a perfect fit. If $U=1$, on the other hand, the predictive performance of the model is as bad as it possibly could be.

The Theil inequality coefficient can be decomposed as follows:

$$\frac{1}{T}\Sigma(Y^s_t - Y^a_t)^2 = (\bar{Y}^s - \bar{Y}^a) + (\sigma_s - \sigma_a)^2 + 2(1-P)\sigma_s\sigma_a$$

where $\bar{Y}^s$, $\bar{Y}^a$, σ_s and σ_a are the means and standard deviations of the series Y^s_t and Y^a_t, respectively, and ρ is their correlation coefficient. The proportions of inequality can be then defined as:

$$U^M = \frac{(\bar{Y}^s - \bar{Y}^a)^2}{\frac{1}{T}\Sigma(Y^s_t - Y^a_t)^2},$$

$$U^s = \frac{(\sigma_s - \sigma_a)^2}{\frac{1}{T}\Sigma(Y^s_t - Y^a_t)^2}, \text{ and}$$

$$U^C = \frac{2(1-\rho)\sigma_s \sigma_a}{\frac{1}{T}\sum (Y^s_t - Y^a_t)^2}$$

The proportions, U^M, U^S, and U^C are called the bias, the variance, and the covariance proportions, respectively, and they are useful as a means of breaking the simulation error down into its characteristic sources, and $U^M+U^S+U^C=1$.

The bias proportion U^M is an indication of systematic error, since it measures the extent to which the average values of the simulated and actual series deviate from each other. Whatever the value of the inequality coefficient U, for good performance of the model, U^M should be close to zero.

The variance proportion U^S indicates the ability of the model to replicate the degree of variability in the variable of interest. If U^S is large, it means that the actual series has fluctuated considerably while the simulated series shows little fluctuation, or vice versa. This would be troubling and might lead to a revision of the model.

Finally, the covariance proportion U^C measures what it might be called unsystematic error, i.e., it represents the remaining error after deviations from average values and average variabilities have been accounted for. Indeed, for any value of $U>0$, the ideal distribution of inequality over the three sources is $U^M=U^S=0$, and $U^C=1$.

<u>(7/2/7/1) The Performance of the Models, 1963-1982:</u>

A final test of the descriptive validity of the demand models, is obtained by comparing the predicted values of the endogenous variables with the values actually observed during the sample period. In Tables (7.8), (7.9), (7.10), (7.11), (7.12), (7.13) and (7.14), the estimated and actual values of the petroleum products consumption in Egypt are listed side by side. The comparison of the estimated and the actual values indicates that the models are able to track the time paths of the endogenous variables. Table (7.6) presents a summary statistics of the historical simulation of the model. They also show the goodness of fit of the models.

The results presented in this section indicate that the demand for petroleum products is influenced by changes in price and income, although the effects of the short-run are small and smaller than those of the long-run.

<u>(7/2/7/2) Policy Simulation:</u>

The second main objective of the simulation exercise undertaken in this section, is to simulate how the demand for petroleum products in Egypt might have responded to alternative levels of prices for the years 1963-1982. In this concern, some points should be noted at first:

Table (7.6) Summary Simulation Statistics

Dependent Variables	MAE	Rms Error	U	U^M	U^S	U^C
Q_1	0.758	0.979	0.0027	3.79D-14	0.005	0.995
Q_2	3.42	4.24	0.0016	0.0	0.02	0.98
Q_3	0.136	0.176	0.00099	4.58D-15	0.001	0.999
Q_4	0.715	0.884	0.0008	1.2D-14	0.01	0.989
Q_5	0.967	1.26	0.001	0.0	0.0025	0.9975
Q_6	0.282	0.341	0.0036	4.9D-15	0.0079	0.992
Q	5.3	6.4	0.00099	0.0	0.0077	0.9923

MAE = Mean absolute error

Rms Error = Root mean squared error

U = Theil's inequality coefficient

U^M = Fraction of error due to bias

U^S = Fraction of error due to different variation

U^C = Fraction of error due to different co-variation

1. Three different increases in petroleum products prices 10%, 20% and 30%, have been used to simulate the impact of different increases on petroleum products consumption. In a study done by the World Bank[22] in 1981 on the alternative policies to increase petroleum products prices in Egypt during 1980-1990 so that they can be comparable with the World prices levels by 1990, it was suggested that the annual rate of increase is anticipated to be 16% for Gasoline, 42% for Fuel oil, 33% for LPG, 35% for Kerosene, 35% for Gas oil and 36% for Diesel oil.

2. Although direct and indirect effects of prices increases have been examined, these effects do not include the effects of the supply side on petroleum products consumption, and also they do not include the effects on the other variables in the economy such as the impact on other commodities prices, on income distribution, on real wages, and on other sectors which use petroleum products as inputs. The direct impact is taken to mean the impact of price changes on petroleum products consumption. Whereas the indirect impact is taken to mean the impact of prices changes on macro-economic aggregates i.e. national income and its components.

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[22] H. Abdulla, Alternative Scenarios For Pricing Petroleum Products In Egypt, (Oil & Arab Cooperation, vol.10.No.1, 1984)pp.103-151.

<u>(7/2/7/2/1) The direct effects of Prices Increases:</u>

Simulation results of petroleum products consumption are presented in Tables (7.7), (7.8), (7.9), (7.10), (7.11), (7.12), (7.13) and (7.14): Table (7.7) presents the simulation results of consumption changes on average before and after prices increases. It shows that the impact of price increases on domestic consumption in the case of Fuel oil, Gas oil and Diesel oil, is not very clear. This may be explained by the difficulty found in specifying a significant demand equations for them employing their prices and which in turn affected the performance of the equations because of their artificial values due to subsidy system as explained before. On the other hand, these products in particular Fuel oil and Gas oil are necessary goods since they are mainly consumed by the vital sectors in the economy (i.e. industry, electricity, and transportation), and this is reflected by the very low price elasticities as shown in Table (7.5). Table (7.7) also shows that:

1. a 10% price increase led to a reduction in domestic consumption of petroleum products ranging from 0.3% in the case of Fuel oil and 1.7% in the case of Diesel oil to 9.5% in the case of Gasoline;
2. a 20% increase in prices led to a reduction in domestic consumption ranging from 0.64% in the case of Fuel oil to 15.43% in the case of Gasoline;

Table (7.7) Simulation Results of the Average Changes in Petroleum Products Consumption

Products Consumption	Actual	SQ_i	10% Price Increase		20% Price Increase		30% Price Increase	
			S_1Q_i	% Change to Actual	S_2Q_i	% Change to Actual	S_3Q_i	% Change to Actual
Q_1	17.5	16.84	15.83	9.5	14.8	15.43	13.8	21.4
Q_2	103.81	103.85	103.5	0.3	103.15	0.64	102.8	1
Q_3	4.825	4.836	4.58	5.1	4.324	10.4	4.07	15.65
Q_4	31.13	31.27	30.2	3	29.11	6.5	28.04	10
Q_5	37.225	37.291	37.28	-	37.27	-	37.25	-
Q_6	5.32	5.3	5.23	1.7	5.17	2.82	5.11	4
Q	210	210.26	200	5	189.13	10	179.6	14.5

Where SQ_i = Simulated consumption before price increases and $i = 0,\ldots,6$

S_jQ_i = Simulated consumption after price increases and $i = 0,\ldots,6$
$j = 1,2,3.$

Table (7.8) Simulation Results of Q1 Before

And After Increases in the Price by 10%, 20%, 30%

	Q1	SQ1	S1Q1 10%	S2Q1 20%	S3Q1 30%
1963	9.57143	8.37981	7.12981	5.87981	4.62981
1964	9.65517	9.17806	7.99161	6.80517	5.61873
1965	9.76190	10.09367	8.98256	7.87145	6.76034
1966	8.56667	10.17015	9.05421	7.93827	6.82233
1967	11.32258	9.78339	8.71490	7.64640	6.57791
1968	12.53125	11.59875	10.51424	9.42974	8.34523
1969	13.51515	12.35355	11.25496	10.15637	9.05778
1970	15.73574	13.58977	12.53644	11.48310	10.42977
1971	16.67647	14.95561	13.87561	12.79561	11.71561
1972	14.00000	15.16755	14.03598	12.90440	11.77282
1973	14.75000	13.09133	11.94071	10.79009	9.63948
1974	15.93046	15.25152	14.24937	13.24722	12.24507
1975	18.16216	16.39307	15.40307	14.41307	13.42307
1976	19.63158	19.06167	18.14500	17.22834	16.31167
1977	21.82051	21.35003	20.51105	19.67207	18.83309
1978	24.42500	24.32294	23.58960	22.85627	22.12294
1979	24.75610	25.34490	24.46652	23.58814	22.70976
1980	27.57143	26.04358	25.11540	24.18722	23.25904
1981	29.65116	29.47930	28.61776	27.75622	26.89469
1982	32.05817	31.27627	30.42181	29.56735	28.71289

Table (7.9) Simulation Results of Q2 Before

And After Increases in the Price by 10%, 20%, 30%

	Q2	SQ2	S1Q2 10%	S2Q2 20%	S3Q2 30%
1963	94.39286	96.73991	96.20544	95.67098	95.13652
1964	99.96552	97.78760	97.25252	96.71743	96.18234
1965	102.38095	100.36710	99.86598	99.36487	98.86376
1966	104.16666	101.17398	100.71645	100.25891	99.80138
1967	97.38710	101.03349	100.60103	100.16856	99.73610
1968	100.59375	97.16795	96.75217	96.33640	95.92062
1969	90.78788	97.46244	97.02934	96.59624	96.16315
1970	91.26126	93.26886	92.85886	92.44886	92.03886
1971	94.26471	92.68652	92.27651	91.86652	91.45651
1972	91.48572	93.38125	92.97665	92.57204	92.16743
1973	91.63889	91.77512	91.39549	91.01586	90.63623
1974	91.20879	92.59846	92.26782	91.93717	91.60653
1975	98.35135	93.25069	92.94319	92.63570	92.32819
1976	105.57895	98.72919	98.44447	98.15974	97.87502
1977	110.05128	105.51838	105.25779	104.99719	104.73660
1978	104.55000	110.08418	109.85640	109.62862	109.40084
1979	102.24390	113.02400	112.81623	112.60846	112.40069
1980	123.14286	121.18903	121.01914	120.84925	120.67936
1981	136.23256	136.51216	136.35446	136.19678	136.03908
1982	146.48769	143.31331	143.16895	143.02458	142.88022

Table (7.10) Simulation Results of Q3 Before

And After Increases in the Price by 10%, 20%, 30%

	Q3	SQ3	S1Q3 10%	S2Q3 20%	S3Q3 30%
1963	1.46429	1.35130	1.02769	0.70407	0.38046
1964	1.82759	1.58510	1.26088	0.93665	0.61243
1965	2.00680	2.23341	1.94575	1.65809	1.37044
1966	2.46667	2.13872	1.81771	1.49671	1.17570
1967	2.19355	2.51407	2.21065	1.90723	1.60381
1968	2.53125	2.62150	2.30954	1.99757	1.68561
1969	2.51515	2.84208	2.53012	2.21815	1.90619
1970	3.24324	3.26940	2.97407	2.67874	2.38341
1971	3.50000	3.49668	3.20136	2.90603	2.61070
1972	3.88571	3.77637	3.48493	3.19349	2.90204
1973	4.25000	4.18966	3.91620	3.64275	3.36930
1974	4.36813	4.41924	4.13777	3.85630	3.57483
1975	4.83784	4.95196	4.69019	4.42842	4.16665
1976	5.57895	5.61400	5.37162	5.12925	4.88687
1977	6.35897	6.38678	6.16494	5.94311	5.72127
1978	7.40000	7.14183	6.94793	6.75403	6.56013
1979	8.17073	7.99587	7.81900	7.64213	7.46526
1980	9.09524	9.29454	9.14992	9.00529	8.86067
1981	10.16279	10.19964	10.06540	9.93116	9.79692
1982	10.64877	10.69939	10.57550	10.45260	10.32970

Table (7.11) Simulation Results of Q4 Before

And After Increases in the Price by 10%, 20%, 30%

	Q4	BQ4	S1Q4 10%	S2Q4 20%	S3Q4 30%
1963	31.00000	30.12360	28.96324	27.80288	26.64252
1964	31.17241	30.83175	29.73039	28.62904	27.52768
1965	31.56463	31.62025	30.58883	29.55740	28.52597
1966	31.96667	32.66488	31.72314	30.78140	29.83966
1967	28.16129	30.03794	28.81986	27.60178	26.38370
1968	23.65625	24.54484	22.90709	21.26935	19.63160
1969	23.87879	23.02075	21.38300	19.74546	18.10751
1970	24.62462	26.54605	25.25101	23.95597	22.66093
1971	27.64706	26.80974	25.51470	24.21966	22.92462
1972	28.08571	28.02289	26.74489	25.46689	24.18889
1973	28.69444	28.97328	27.77417	26.57506	25.37595
1974	30.46703	30.76815	29.72376	28.67937	27.63499
1975	32.10811	30.85255	29.75131	28.65007	27.54883
1976	33.02632	32.32557	31.30590	30.28623	29.26657
1977	33.46154	33.63794	32.70469	31.77143	30.83818
1978	34.50000	35.06324	34.24751	33.43177	32.61604
1979	35.36585	35.01794	34.14445	33.27097	32.39748
1980	35.78571	37.19236	36.47812	35.76389	35.04966
1981	37.58139	38.07058	37.40763	36.74467	36.08172
1982	39.86577	39.30999	38.70306	38.09613	37.48920

Table (7.12) Simulation Results of Q5 Before

And After Increases in the Price by 10%, 20%, 30%

	Q5	SQ5	S1Q5 10%	S2Q5 20%	S3Q5 30%
1963	27.42857	26.58076	26.56790	26.55505	26.54219
1964	29.00000	27.53400	27.52179	27.50959	27.49739
1965	29.79592	28.96802	28.95659	28.94516	28.93373
1966	30.80000	29.61095	29.59344	29.57593	29.55843
1967	30.93548	30.20253	30.18599	30.16944	30.15289
1968	30.90625	30.23306	30.21605	30.19903	30.18202
1969	29.06061	30.34305	30.32604	30.30902	30.29201
1970	29.87988	29.65223	29.63612	29.62001	29.60391
1971	30.17647	30.29832	30.28221	30.26610	30.25000
1972	30.11429	30.72536	30.70947	30.69357	30.67768
1973	29.61111	30.90499	30.89008	30.87517	30.86025
1974	28.98351	31.30849	31.29551	31.28252	31.26953
1975	31.86486	31.78929	31.77721	31.76513	31.75305
1976	34.92105	35.13326	35.12207	35.11089	35.09970
1977	37.97436	39.19224	39.18200	39.17177	39.16153
1978	42.65000	42.68707	42.67812	42.66917	42.66022
1979	48.12195	48.40674	48.39858	48.39042	48.38226
1980	54.28571	56.38964	56.38162	56.37360	56.36557
1981	66.83721	63.70039	63.69294	63.68550	63.67805
1982	71.16331	72.16811	72.16129	72.15447	72.14765

Table (7.13) Simulation Results of Q6 Before

And After Increases in the Price by 10%, 20%, 30%

	Q6	SQ6	S1Q6 10%	S2Q6 20%	S3Q6 30%
1963	8.39286	8.29414	8.22690	8.15967	8.09244
1964	8.34483	8.05309	7.98927	7.92546	7.86165
1965	8.43537	8.01901	7.96925	7.90949	7.84872
1966	8.13333	8.04556	7.98008	7.91461	7.84913
1967	7.16129	7.80370	7.74181	7.67992	7.61803
1968	6.84375	6.66041	6.57345	6.48648	6.39951
1969	6.54545	6.36319	6.27623	6.18926	6.10230
1970	5.43544	6.12010	6.03777	5.95544	5.87312
1971	4.76471	5.09214	5.00982	4.92749	4.84516
1972	5.02857	4.47582	4.39458	4.31334	4.23209
1973	4.97222	4.76049	4.68426	4.60803	4.53180
1974	4.61538	4.77990	4.71351	4.64712	4.58072
1975	4.21622	4.46459	4.40284	4.34109	4.27835
1976	3.94737	4.07688	4.01971	3.96254	3.90536
1977	3.82051	3.78728	3.73496	3.68263	3.63030
1978	3.82500	3.56056	3.50404	3.44751	3.39099
1979	3.63415	3.49490	3.44334	3.39178	3.34023
1980	3.42857	3.22166	3.17950	3.13734	3.09518
1981	2.44186	2.91433	2.87520	2.83607	2.79694
1982	2.46085	1.99387	1.95805	1.9222	1.88640

Table (7.14) Simulation Results of Q Before And After Increases in the Price by 10%, 20%, 30%

	Q	SQ	S1Q	S2Q	S3Q
1963	178.32143	181.58797	170.74008	159.89221	149.04434
1964	168.27586	187.44124	177.08020	166.71915	156.35811
1965	194.86395	198.58546	189.13478	179.68410	170.23343
1966	197.06667	195.11615	185.22266	175.32918	165.43570
1967	160.32259	169.52853	157.07765	144.62674	132.17586
1968	177.18750	172.06036	159.88017	147.69998	135,51981
1969	125.45454	122.82023	105.66521	88.51019	71.35518
1970	177.74776	177.85892	166.05733	154.25572	142.45415
1971	182.82353	175.18277	163.04619	150.90959	138.77301
1972	179.02856	179.39798	167.48311	155.65823	143.83337
1973	184.02777	185.21553	173.89897	162.58243	151.26588
1974	182.99449	197.84479	187.52013	177.19545	166.98080
1975	206.10811	206.41762	196.61519	186.81276	177.01036
1976	229.47368	223.64511	214.90335	206.16161	197.41986
1977	243.53847	239.07846	230.97295	222.86743	214.76192
1978	236.70000	247.99583	240.10132	232.20680	224.31229
1979	258.07318	259.75882	251.84624	243.93365	236.02109
1980	269.59525	277.93979	269.92874	261.91772	253.90671
1981	304.65115	300.15878	292.88504	285.61130	278.33755
1982	324.38480	397.75632	300.78479	293.81323	286.84171

3. However, a 30% prices increases led to a reduction in domestic oil consumption ranging from 1% in the case of Fuel oil to 21.14% in the case of Gasoline; and

4. On aggregate level, a 10%, 20% and 30% increase in the average weighted price of petroleum products led to a reduction in total consumption of petroleum products by 5%, 10% and 14.5% respectively.

(7/2/7/2/2) The Indirect Impact of Prices Increases:

In order to examine the effects of petroleum products prices increases on macro-economic aggregates mainly national income and its components, the macro-econometric model developed in Chapter (6) has been used. In this model, the impact multiplier has been analysed in order to examine the impact of oil exports (as exogenous) on the macro-economy and the results has revealed that oil exports has a reasonable impact on the Egyptian economy.

Therefore, in order to investigate the effects of petroleum prices increases on the macro-economic aggregates, a conjunction between the demand models of petroleum products and the macro-econometric model developed in Chapter (6), should be made. Accordingly, an econometric model for oil exports has been developed in this section in order to investigate the main factors affect oil exports in Egypt.

In general, oil exports in Egypt is mainly determined by three main factors: 1) Egypt's share of oil production and which is defined on average by 80% of profit oil according to oil agreements as explained in section (3/3/2/1); 2) domestic oil consumption since one of the main objectives of the oil sector is to satisfy domestic needs; and finally, the export price of crude oil. Since there was no data available for export prices of crude oil, the average real price has been calculated simply by dividing the value of oil exports by it volume.

In the light of the above considerations, different specifications of the oil exports function have been estimated. However, the equation which gave reasonable results at the same time includes all the three main determinants has been adopted. The results has been as follows:

$$\underset{(1.9)}{X = 89} + \underset{(1.124)}{3.5\ OP} - \underset{(-2.5)}{24.6\ Q} + \underset{(41.5)}{8.95\ PX}$$

s.e. = 36.4 $\quad R^2 = 0.997 \quad$ DW = 2.15
F = 2483.3

where

X = oil exports in million Egyptian pounds;

OP = oil production in million metric tonnes;

Q = domestic oil consumption in million metric tonnes; and

PX = the average real price of oil exports.

Having estimated the oil exports model, the model has been used to simulate the impact of price increases of petroleum products, on the oil exports and which in turn affect the macro-economic aggregates. Table (7.15) shows simulation results of oil exports before and after price increases 1963-1982. The results also show that a 10% increase in petroleum products prices led to 5% decrease in domestic consumption of oil and which in turn led to 2.5% increase in oil exports. While a 20% increase in petroleum products prices led to reduce domestic oil consumption by 10% on average, and which in turn led to 5% increase in oil exports. Also a 30% increase in petroleum products prices led to about 15% reduction in domestic consumption of oil on average and which in turn led to 7.4% increase in oil exports.

Simulation results of the impact of price increases of petroleum products on macro-economic aggregates i.e. national income and its components via oil exports multiplier are shown in Table (7.16). Table (7.16) shows that the increases in petroleum products prices by 10%, 20% and 30% led to increases in gross national product by 2.2%, 4.35% and 6.44% respectively. Also the increases in petroleum products led to increase in all national income components as shown in Table (7.16).

Table (7.15) Simulation Results of Oil Exports Before And After Petroleum Products Prices Increases by 10%, 20%, 30%

	X	SX	S1X	S2X	S3X
1963	22.40000	23.31199	29.44589	35.57979	41.71369
1964	22.20000	12.56586	19.20222	25.83858	32.47493
1965	18.00000	3.07747	10.11555	17.15362	24.19169
1966	15.30000	-2.81784	4.44505	11.70795	18.97083
1967	14.10000	31.79211	37.89775	44.00340	50.10904
1968	15.00000	6.88310	13.84870	20.81429	27.77988
1969	19.00000	38.99371	44.07970	49.16569	54.25167
1970	31.00000	10.97017	18.24166	25.51315	32.78464
1971	29.00000	2.23588	9.87224	17.50860	25.14495
1972	18.00000	-6.35561	1.34217	9.03995	16.73773
1973	25.00000	-2.54125	5.59757	13.73638	21.87519
1974	73.00000	156.97173	165.15477	173.33780	181.52084
1975	124.00000	143.90318	153.27171	162.64026	172.00879
1976	252.00000	183.46458	194.17711	204.88963	215.60214
1977	284.00000	311.81415	323.48245	335.15073	346.81903
1978	372.00000	434.56122	446.19266	457.82410	469.45554
1979	1341.00000	1331.08484	1344.08362	1357.08240	1370.08118
1980	2145.00000	2152.09375	2166.00415	2172.91431	2193.82471
1981	2408.00000	2392.26782	2408.36108	2424.45459	2440.54785
1982	2214.00000	2186.14478	2203.95801	2221.77124	2239.58447

Table (7.16) The Impact of Petroleum Product Increases on National Income and its Components

National Income and Its Components	Oil Exports Multiplier	10% Price Increase	20% Price Increase	30% Price Increase
		5% Reduction in Q	10% Reduction in Q	15% Reduction in Q
		2.5% Increase in X	5% Increase in X	7.4% Increase in X
y	0.87	2.2%	4.35%	6.44%
y_d	0.4	1%	2%	3%
C	0.686	1.715%	3.43%	5.1%
I	1	2.5%	5%	7.4%
N	1	2.5%	5%	7.4%
M	1.86	4.65%	9.3%	13.8%
T	0.51	1.3%	2.55%	3.8%

Where y = Gross national product

y_d = Disposable income

C = Total consumption

I = Total investment

N = Total exports

T = Tax revenue

Q = Total consumption of petroleum products

X = Oil exports

M = Total imports

(7/3) The Supply Side:

The main concern of the study in this section is not to develop and estimate a supply model of oil but rather to investigate the main factors affecting or determining oil supply in Egypt and to examine to what extent these factors could be controllable and then oil could be depleted so that its utilization could be maximized. In this respect, three main factors have been examined. These are, 1) oil reserves; 2) depletion policy and 3) government policy.

(7/3/1) Oil Reserves:

Oil supply is defined as "the depletion of a stock, which is constantly being renewed by adding new reservoirs and expanding the limits of the old ones".[23]

In the oil industry, the target of exploration and the unit of production is the reservoir. The reservoir is thus the natural unit of analysis when analysing the supply of oil.

Activities of oil supply fall into two distinctly different categories: the exploration for and discovery of reservoirs; and the development and production of those reservoirs found. This separation of the discovery/development process, however, does allow the separation of the geological characteristics of an area to

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[23] M.A. Adelman & H.D. Jacoby, Alternative Methods of Oil Supply Forecasting, In R.S. Pindyck (ed.), Advances In The Economies of Energy and Resources, (JAI Press INC., 1979), P.5.

be discovered from the economic attractiveness of the area. In other words, it does allow the risk involved in exploring for hydrocarbons to be subdivided into two categories: the geologic risk and the economic risk. The geologic risk results from the lack of a technology to determine, prior to drilling whether a prospect is, in fact, a reservoir, i.e., contains hydrocarbons. This geologic risk is represented by the probability of hitting a prospect with no hydrocarbon fluids. The economic risk results from the fact that some of the reservoirs discovered may not contain hydrocarbons in commercially attractive quantities.[24]

There are two main approaches to the analysis of oil supply. The most ambitious of these is an approach where in the analyst specifies and estimates structural relationships which relate factor inputs and outputs at each stage of the supply process: exploration; discovery, reservoir development, and production. Then, contingent on prices, factor costs, the tax regime, and miscellaneous public constraints, activity levels are determined which optimize the economic return to petroleum operators. This approach is labeled a disaggregated process approach. However, such approach requires the most data, geological interpretation, and computational capacity. The second approach is the aggregated country analysis and which is

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[24] P.L. Eckbo, A Basin Development Model of Oil Supply, In R.S. Pindyck (ed.), op.cit., p.40

among the most simple of the approaches in terms of less data required.[25]

Following the aggregated approach, such approach is based on forecasts of rig activity and analysis of proved reserves added per rig year. Reserve additions then become an input to calculations of capacity expansion and likely oil production.

Given an estimate of current proved reserves (R_t), the associated production (Q_t) and the number of rigs operating in the area (RY_t), the reserves added per rig time unit (RA), is calculated as:

$$RA = [\ R_{75} - R_{72} + \sum_{t=73}^{75} Q_t\ ] \quad \sum_{t=73}^{75} RY_t$$

A forecast of reserves additions could be obtained by applying the previous equation to subsequent years' drilling rate as:

$$\Delta R_t = RY_t \, . RA$$

To account for the diminished yield from new investment through depletion, Adelman and Jacoby defined a coefficient (b_t) to reflect the diminishing yield. Assuming (CUM R_t) is all past production plus current proved reserves

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[25] P.L. Eckbo, Ibid, p.41 and M.A. Adelman & H.D. Jacoby, Alternative Methods of Oil Supply forecasting, op.cit., pp.7-37

in year t, and (ULt R_t) ultimate recoverable reserves, (b_t) is calculated as

$$b_t = \left[1 - \frac{\text{CUM } R_t}{\text{ULt } R_t} \right] \left[1 - \frac{\text{CUM } R_{75}}{\text{ULt } R_{75}} \right]$$

The reserve addition formula then becomes:

$$\Delta R_t = RY_t \,.\, RA \,.\, bt$$

From the previous discussion, it can be concluded that one of the main elements determining oil supply in any country, is its oil reserves and which in turn depend on the number of reservoirs discovered and their sizes. However, in oil activities a great deal of uncertainty and risk are involved in particular in exploration activity. Not only uncertainty and risk in discovering a reservoir but also in discovering reservoir contains hydrocarbons in commercially attractive quantities. Therefore, the expansion and intensification of exploration activity is a very important matter in order to secure oil supply in the country.

In the case of Egypt, as a result of increasing investment in exploration there were 12 discoveries in 1980, 10 in 1981, 13 in 1982 and 17 in 1983 as shown in Table (3.4). As a result, the proven reserve of oil increased about 5.8 times during the period 1960-1969, and still continues to increase until it reached 3325 million barrels in 1982 as shown in Table (3.5).

(7/3/2) Depletion Policy:

"The rate at which a society should choose to deplete its stock of an exhaustible resource (such as oil) will naturally depend on the size of these stocks; the alternatives to the resource concerned in its various applications, and its value in use. Even if one had complete information about every one of these factors, the choice of a depletion policy would still be a matter of considerable technical complexity and political contentiousness, involving as it does difficult economic and technical considerations and political judgements about the balance to be struck between present and future needs".[26]

In order to show how the intertemporal allocation of a non-renewable resource, such as oil, occurs, the following model is examined.[27]

Consider a producer of oil who possesses a capital stock of oil (Q) which is capable of being extracted at varying rates over time (q_{t+1}, q_{t+2}, ..., q_{t+n}). The producer is faced by an investment decision. He cannot add to his oil stock but keeping it in the ground is investment

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[26] G. Heal, Uncertainty and The Optimal Supply Policy For An Exhaustible Resource, In R.S. Pindyck, op.cit., p.119.
[27] C. Robinson, Energy Depletion and The Economies of OPEC, (Henley Centre For Forecasting, Occasional Paper No.1, 1975).

in resource (V_r) whereas extracting it (q) is disinvestment. As it is an investment decision, he must compare between investment in oil stock (i.e. not producing) and the alternative investment he could make (i.e. producing and investing the revenues). In this case, he will compare the net present values (NPV_s) of all alternative investments open to him, assuming that he aims at maximizing the expected net present value of his future investment programme.

The producer has an expected revenue stream from the sale of future output at future prices. His expected net cash flow will be this revenue stream minus the expected cost stream including taxes and royalties levied by government. The future price is also assumed to be a net expected price (i.e. expected price minus expected cost), so that the producer's expected net revenue (NR) in year t+1 will be: $NR_{t+1} = P_{t+1}\ q_{t+1}$

and in year t+n will be: $NR_{t+n} = P_{t+n}\ q_{t+n}$

where

P_t = net expected price in year t

q_t = output extracted in year t

then, the producer's objective function is

$$\text{Max NPV} = \sum_{t=0}^{n} \frac{(NR)_t}{(1+r)^t}$$

subject to $q \leqslant Q$ and $q \geqslant$ zero

The three significant variables (where the capital stock Q is given), are: the producer's discount rate (r) and this is clearly an uncontrollable variable since it will depend on market rates of interest; the quantity extracted (q) and this is a policy instrument so long as the producer has freedom to control his oil production programme; and the net expected price (P) and this will be nearer to a policy instrument the nearer the oil market is to monopoly, but to an uncontrollable variable if the market becomes more competitive. In the case of Egypt, if the oil producers are simply divided into two groups:[28] price-maker group and price-taker group, Egypt is considered to be a price-taker producer. Thus the price variable becomes an uncontrollable variable in this case.

If P is assumed to be exogenous so that q is the only variable under the oil producer's control, then the producer's output decision becomes a function only of his expectations about interest rates and prices. So, if the producer has in mind a price trend ($\dot{P} = \frac{P}{\partial t}$), which may well be some form of extrapolative expectation, then his problem reduces to comparing the values of the two exogenous variables-his expected rate of net price appreciation ($\dot{P}$) and his expected rate of interest (r). Then the oil producer's decision will be as follows:

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[28] M.A. Adelman & H.D. Jacoby, Alternative Methods of Oil Supply Forecasting, op.cit.

1. If $\dot{P}>r$, there is a tendency to hold oil in the ground to take advantage of high expected rates of price appreciation;
2. If $\dot{P}<r$, there is a tendency to produce oil now because the price appreciation outlook is relatively poor; and
3. In equilibrium, with $\dot{P}=r$, the oil producer is content with its output programme; if he discounts the expected rate of net price appreciation by the market rate of interest, which in this case will be his opportunity cost of capital, he obtains a NPV of zero on marginal investment. Thus there is flow equilibrium in the market for the resources in the sense that the resource owner is indifferent between producing and holding the marginal unit of the resource. Whether he produces the marginal unit, or hold it in the ground he obtains the same return.

The above discussion is only a brief investigation of the main factors affecting an oil producer's decision to deplete his oil in the present or in the future. Although, in practice it is important to consider other factors such as equilibrium in more than just the oil market, because one has to consider demand reactions and possibilities of substituting oil for another resource.[29] The problem is not only how much to produce but also how to sell. In this

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[29] C. Robinson, Energy Depletion and The Economics of OPEC, op.cit., p.7.

case the ability of the demand side i.e. oil importers should be considered.

The discussion has considered so far the way the market mechanism is at present allocating crude oil between today and tomorrow. However, is this market allocation likely to approach the optimum intertemporal oil allocation? If it were to do so, the expected rate of interest would have to approximate the social time preference rate and expected crude oil prices would have to approximate those given by a market in which social costs (pollution for example) were internalized and in which consumers made choices based on full information. Alternatively, deviations in the interest rate in one direction would have to be offset by similar deviations in prices. Moreover, expectations about interest rates and prices would have to be realized. The question is how do expectations about interest rates and prices would in the real world fit these criteria?

"A standard argument is that interest rates tend to exceed social time preference rates, partly because interest rates reflect risks to individual which largely cancel out for society as a whole and partly because they take into account tax which is a transfer within a given society. Thus resources are consumed too fast and we leave too little to future generations".[30] However, this argument ignores the fact that "consumption" of natural

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[30] C. Robinson, Ibid., p.12.

resources is really transformation and that, assuming such transformation can continue, using these resources now means leaving future generations more capital equipment and improved technology compared with what they would have if the resources had been left in the ground.

In a competitive market and which seems to be the case of the world oil market at present time, and if market price of oil is expected to remain constant or slightly fluctuated, a producer would prefer to sell as much as possible now so that he would get a maximum revenue during the earliest period.

In the case of Egypt, there are some other factors are more important than just expected oil price and expected interest rate. Egypt at the present time is facing a difficult stage of rebuilding her economy particularly as Egypt has been in two wars, 1967 and 1973 and which in turn led her physical infrastructure to suffer for a long time from inadequate investment and it has therefore deteriorated considerably. This means that Egypt is very much in need to financial and foreign exchange sources to enable her to restructure her economy. From the discussion in Chapter (3), it has appeared that the petroleum sector in Egypt is one of the main financial and foreign exchange sources if not the most important one. This financial importance of the petroleum sector has been attributable mainly two main factors, the sharp increase in oil price in particular during the 1970s and the beginning of 1980s and the expansion of the sector's production capacity. Crude oil production in 1983 reached a record of about 36 million tonnes i.e 4.8 times the figure of 1974 of 7.5 million and an increase of 9.3% over 1982.[31] The sector's production plans for the future aim at a target of 50 million tonnes (million barrels a day) relying on the promising new discoveries in the Gulf of Suez, Western Desert and other areas especially after regaining the Sinai fields.

However, fast depletion rates for the existing fields, even if compensated for by new discoveries together with rapidly increasing domestic consumption, is going to lead to a declining rate in oil production levels and consequently in oil exports and thus in the financial ability of the sector.

The above discussion reveals that the link between oil production policy and economic development needs seems very important. The question could be raised now is what is the reasonable or relatively optimal policy of oil production and which would help the economy to be rebuilt and develop? Although producing oil now rather than in the future seems, at the first glance to be a policy that does not account for future generations. However, on the other hand if such policy is to produce oil on a level sufficient to be exchanged for a financial resource and which could be invested in capital formation and thus developing the basic

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[31] See Table (2.6).

productive sectors particularly industry and agriculture, this policy would be the relatively optimal policy of oil production for Egypt as a country at stage of rebuilding and developing her economy. This policy is, thus taking account for future generation by directing oil revenues to future welfare, through investment channels.

The question might be raised, however, is on what basis the sufficient level of oil production could be defined. In this respect. the concept of absorptive capacity seems important as the base for oil supply in Egypt. However, the measurement of the absorptive capacity is beyond this research and therefore is left for another research.

(7/3/3) Government Policy:

The oil production policy, in Egypt, is complementary to other economic and social policies. The achievement of such economic and social policies depends to a great extent on oil, either as a source of energy or as a major financial source of economic and social plans through export earnings.

Since the oil sector in Egypt is owned completely by the government, oil production policy is determined directly according to government policies and plans for the whole economy and the energy sector. As a result of oil prices increases during the 1970s and the beginning of 1980s, the Egyptian government has adopted a production policy which could be defined according to C. Robinson and

I. Marshall, as a "Repletion Policy".[32] They define such policy as a policy which aims to increase the total amount of oil production in some given period of time by accelerating the rate of depletion. This implies that the time distribution of output can be changed without increasing total recoverable reserves. These, however, might diminish if depletion rates are accelerated, regardless of the physical characteristics of each field. In spite of all these considerations, the government of Egypt, through the EGPC, is at present adopting a policy of accelerating production of crude oil depending on the promising potential discoveries and the intensified exploration activities as explained in Chapter (3).

(7/4) Concluding Remarks:

The present chapter has been to investigate the main factors affecting oil consumption and oil supply in Egypt.

On the demand side, the analysis of the demand for petroleum products in Egypt has depended on a simple demand model and therefore, policy actions should be proposed with caution. The results have indicated that price elasticities for petroleum products are all consistent with economic theory. The long-run price elasticities on disaggregate level are ranging from-0.06 in the case of

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[32] C. Robinson and I. Marshall, Oil's Contribution to UK Self-Sufficiency. (Energy Paper No. 12, Heinemann Educational Books, London, 1984).

Fuel oil to -2.11 in the case of Gasoline. The very low price elasticity in the case of Fuel oil may be explained by the artificial value of its price due to subsidy system where its price is highly subsidized. On the other hand, the long-run income elasticities for petroleum products are very low. This is an unexpected result because petroleum products are considered to be superior fuels in Egypt. Since R^2 for petroleum products models are quite high ranging from 0.9 in the case of Fuel oil to 0.99 in the case of LPG and Gas oil reflecting the goodness of fit of the models, the low elasticities could be attributable to the very low prices of petroleum products in Egypt due to subsidy system and which in turn affected the performance of the models. The income elasticity for Diesel oil gave the wrong negative sign reflecting that Diesel oil is an inferior good because of the existence of substitutes such as Gas oil.

On aggregate level, price and income elasticities are quite low although price elasticity is relatively higher, and they are -0.503 and 0.134 respectively.

At any rate, the results show that price elasticities for petroleum products give reasonable evidence for the influence of prices on petroleum products consumption, although the short-run effects are small. Also it can be concluded that the low elasticities mean that petroluem products are necessary goods for the economy. It can be also explained to some extent by the very low artificial values of some Fuels prices such as Fuel oil since it is highly subsidized.

The simulation exercise has been carried out using three different increases in petroleum products prices 10%, 20%, and 30%. The results show that a 10% price increase led to a reduction in domestic consumption of petroleum products ranging from 0.3% in the case of Fuel oil and 1.7% in the case of Diesel oil to 9.5% in the case of Gasoline. While a 20% price increase led to a reduction in domestic consumption ranging from 0.64% in the case of Fuel oil to 15.43% in the case of Gasoline. Finally, a 30% price increase led to a reduction in domestic consumption ranging from 1% in the case of Fuel oil to 21.14% in the case of Gasoline.

On aggregate level, a 10%, 20% and 30% increase in the average weighted price of petroleum products led to a reduction in total consumption of petroleum products by 5%; 10% and 14.5% respectively.

In order to examine the effects of petroleum products prices increases on macro-economic aggregates mainly national income and its components, the macro-econometric model developed in Chapter (6) has been used. In this model, oil exports have been assumed to be exogenous in order to examine the impact multiplier of oil exports on the macro-economy. Therefore, in order to investigate the effects of price increases on the macro-economic aggregates, a conjunction between the demand model for petroleum products and the macro-econometric model has been made by developing an econometric model for oil exports in Egypt.

The results show that the increases in petroleum products prices by 10%; 20% and 30% led to increases in gross national product by 2.13%, 4.26% and 6.3% respectively on its level in 1981. These increases in petroleum products prices led also to increases in all national income components.

It is noteworthy that although direct effects (i.e. the effects on domestic consumption of petroleum products) and indirect effects (i.e. the effects on macro-economic aggregates) of prices increases have been examined, these effects do not include the effects of the supply side and they do not include the effects on the other variables in the economy such as the impact on other commodities prices, on income distribution, on real wages, and on other sectors which use petroleum products as inputs.

It could be concluded, from the previous results that reconsidering the domestic pricing policy of oil in Egypt and raising domestic prices of petroleum products is very crucial in order to decrease and rationalize domestic consumption of petroleum products in particular the analysis of the subsidy system of petroleum products in Egypt has revealed that the system has not achieved its main goals.

Chapter (8)

Summary and Conclusion

The main concern of this thesis is to evaluate the effects of the Egyptian petroleum sector on economic development process in Egypt during the period 1962-1982 within both micro and macro-economic approaches.

Since the oil sector depends in a high percentage on foreign trade, and in order to examine its impact on the Egyptian economy, Chapter (2) has dealt with the theoretical background of the study depending mainly on two main grounds: First, on the economic theory which addressed the role that can be played by the primary exports in promoting economic development of developing countries, and Secondly, on the unbalanced growth argument, in order to examine to what extent the oil sector is a good leading sector in developing countries.

The investigation of the existing theories of trade, growth and development has revealed that there are two main schools of economic thought regarding the contribution of international trade, particularly based on primary products, to the economic development of developing countries. The first school basically composes of the trade theory economists and the staple theory economists. The trade theory economists, in particular classical economists, believe that international trade has a positive impact on developing countries because of the factors which play an essential role in economic development of the trading countries. Some of these factors are the stimulation of productivity, vent for surplus and the efficient reallocation of their given resources between domestic and export products in the light of the comparative advantage. The staple theory economists argue that the export of primary products has a direct contribution to the rest of the economy. As the demand for the staple export product increases, the quantity supplied also increases, thus, resulting in an increase in income. By spending this income, investment opportunities in the other sectors of the economy would be generated. The international trade economists argue that trade generates "spread effects", and thus promotes the growth of the rest of the economy.

The second school which is composed mainly of Singer-Myrdal-Prebisch arguments and dependency theory economists, considers international trade as having a negative effect on economic development of developing countries. Their view stems from the nature of the exports of developing countries, i.e. primary products. Each economist seems to emphasise a different cause. A summary of the main causes includes 1) the world environment in which the terms of trade are believed to turn systematically against the developing countries, 2) the domestic impediments in developing countries such as factor immobility, price rigidity, narrow domestic market, ..

etc., 3) primary export sector is an enclave sector financed by foreign capital and located in developing countries only in a geographical sense while economically part of the investing country, 4) dependency theory economists see the relations between developed and underdeveloped countries as a chain of exploitation in which the economies of developing countries were forced into a position of complementarity with those of developed countries. Since developed countries aimed at searching for new sources of raw materials, new markets for manufactures, and for new sources of labour to exploit, and as a result of the concentration on primary production for the world market, developing countries have been prevented from industrializing.

As a consequence of these circumstances in the world environment and within the developing countries, the promotion of manufacturing industries has been suggested, since such industries have high domestic linkages and produce a better quality of the labour force and can compete in the world markets. In order to do so, developing countries may follow various strategies. In this connection, a distinction is commonly made between inward-looking and outward-looking industrialization strategies. Inward-looking strategies emphasize import substitution as the major vehicle of industrialization while outward-looking strategies emphasize export promotion as the major vehicle of industrialization.

Examining the unbalanced growth argument and thus the leading sector hypothesis and the criterion which make a good leading sector (i.e. comparative advantage, economies of scale and linkages criterion), the oil sector comes out fairly well as a good leading sector in economic development of developing countries. However, in the case of Egypt, whether it is true or not that the oil sector has a positive impact on the Egyptian economy and comes out fairly well as a good leading sector, has been the matter for empirical investigation and which has represented the main concern of the empirical work of this thesis.

Before examining the main objectives and hypothesis of the study, the study in Chapter (3) has highlighted the main features of the Egyptian petroleum industry in order to examine its main developments and the main aspects which affect its activities. The study then, has revealed the following:

1) There are mainly four major factors that stimulated the growth of the industry during the period under study:

a. the attraction of the Egyptian production-sharing concessions and incentives offered by the Egyptian government for encouraging Arab and foreign investment in oil operations,
b. Egypt has certain characteristics which are accountable for the highly comfortable climate enjoyed by foreign investors. To mention but a few of these endowments,

there are a deep-rooted spirit of respect for contractual relations and a vast and diversified base of manpower skills which provide elements needed for work and an easy atmosphere to discuss problems and reach fair solutions. In a recent study, Egypt came on top of nearly 40 developing countries where the business climate was termed as "attractive",

c. the high success in oil finding and widely established infra-structure to support production and exploration, and

d. increases in world demand for oil.

2) There are four main oil producing areas in Egypt. They are Gulf of Suez, the Nile Delta, the Northern half of the Western Desert, and the Northern half of Sinai Peninsula. The Gulf of Suez is considered to be the most prolific and prospective oil province and therefore exploration activities have been concentrated in it although the other provinces have a very promising hydrocarbon potentials.

3) The growth of the petroleum industry has been largely evidenced by the growth of its exports either in the form of crude oil or petroleum products although a high percentage of oil exports is in crude oil form.

4) The domestic consumption of petroleum products is dramatically increasing at a high rate of growth. This increasing consumption is attributed mainly to the low domestic prices of petroleum products in Egypt due to subsidy system.

The study in Chapter (4) has presented the first step in estimating the impact of the petroleum industry on the domestic economy by examining its direct contribution to foreign exchange earnings, to the balance of payments, to investment and to the public revenue. The study has revealed that the petroleum sector has been the largest contributor to foreign exchange earnings, and contributed fairly well to all of each investment, balance of payments and public revenue.

Since the main concern of the study is to examine the impact of the petroleum sector on the Egyptian economy, Chapter (4) has started by highlighting briefly the main features of the Egyptian economy and the main changes taken place in the economy before and after 1973 as a result of two main factors: The opening policy and the oil revolution. The investigation has shown that these two factors have positively affected the Egyptian economy.

However for the purpose of measuring the total impact (direct and indirect) of the petroleum industry on the rest of the economy and on national income and its components, the approach presented in Chapter (4) is not sufficient. Consequently, and for better understanding of the impact of the petroleum sector on the Egyptian economy, both the input-output and the macro-economic approaches have been used. In Chapter (5), the study has dealt with the application of the input-output model to evaluate two main effects, first, the interindustry linkages of the oil sector with the rest of the economy, and secondly the economic multipliers generated by the growth in the final demand for the output of the oil sector. Before testing such effects, the input-output model has been examined at first, to assess its applicability to developing countries which exhibit a substantial dependence on foreign trade in particular import of inputs for their domestic industries. Also before assessing the above two main effects, the input-output tables have been used in examining the major changes which have taken place in the Egyptian economy.

On the basis of empirical results of the petroleum sector's intersectoral linkages, disposition of its output and the impact multiplier, the following remarks have been concluded:

1) The results show that the petroleum sector has positive impact on the Egyptian economy. Its main contribution to the economy comes from its exports. This contribution can be expected to increase as the oil exports are more in the form of refined products than in the form of crude oil. This means that the petroleum sector would increase its interdependence with the rest of the economy.

2) The backward linkages of oil production sector are relatively low and it can be argued that these linkages can be expected not to increase very much in the future because of the capital intensive nature of its operations which need sophisticated machinery and equipment their local production is presently not possible. However, the

backward linkages of oil refining sector are relatively high and it can be expected these linkages to increase in the future as the sector expands its capacity and its operations. This implies that the oil refining sector will increase its reliance on the domestic sectors and increase its demand for investments and create more chances for employment.

3) The forward linkages of the petroleum sector, on the other hand, are relatively high and it can be expected to increase as the economy is more diversified and the petroleum sector has positive impact on the domestic sectors. This means not only that the forward linkages of the petroleum sector become more meaningful from economic development point of view, but also means that oil exports are more in the form of refined products than in the form of crude oil.

4) The results have also revealed that a high percentage of oil has been consumed domestically. This high percentage is mainly due to the low domestic oil prices in Egypt compared to the international ones due to the subsidy system in Egypt. Therefore, it might be better to review the existing domestic pricing policy in Egypt and increase domestic oil prices to be comparable with the world prices taking into consideration the social effects of such increase and the effects on the other sectors and on the petroleum sector itself.

5) The results also show that the household income multipliers of oil production sector were relatively high, and these of oil refining sector were the highest in the Egyptian economy.

Since the macro-economic approach differs from the input-output approach in the sense that the latter contains specific industry groups with particular production functions and then the macro-economic approach provides a complementary method since it enables a statistical test to be made of the impact of a particular sector on the rest of the economy, the study in Chapter (6), therefore, has aimed at assessing the impact of the oil sector on the Egyptian economy using the macro-economic model. It has been mainly to estimate the impact of the petroleum sector's exports on gross national products and its components during 1962-1981. In order to do so, and to shed more light on the mechanism of the economy, a moderate sized and disaggregated macro-econometric model of the type proposed by L. R. Klein for developing economies, has been designed for the Egyptian economy. In this model, foreign trade is examined in greatest relative detail because of its importance in the open developing economy of Egypt, with special emphasis on exports of primary commodities (oil in particular) and the composition of imports between consumption, investment, raw materials, and services imports. Because of the importance of oil as a foreign exchange earner, exports have been divided into two major products (oil and non-oil exports), and they have been considered to be exogenously determined.

The solution of the proposed macro-economic model has indicated that the impact multiplier of the oil sector's exports on gross domestic product is higher than that of the non-oil exports. Also the estimates show a higher impact multiplier of the oil exports on disposable income than that of the non-oil exports. However, the estimates have shown that the impact multipliers of the oil exports on gross domestic product and disposable income are relatively low. This might be due to the leakage items of the economy (such as imports).

The investigation of the correlation between the rates of growth of value added in the petroleum sector on one hand and the rates of growth of value added in the other sectors on the other hand, has revealed that there has been a positive correlation between them although the correlation coefficients were relatively low. This might imply that the financial contribution of the oil sector might not have been utilized rationally and/or there are other factors other than oil have caused the growth in the rest of the economy. In addition, the non-oil sectors might have been hindered by some other factors other than the availability of financial resources (e.g. lack of technology and entrepreniourship..etc).

On the basis of the empirical investigation of the micro and macro effects of the oil sector on the economy, it can be concluded that the oil sector comes out fairly well as a good leading sector in the Egyptian economy.

The study in the previous chapters has revealed three main facts. First the domestic consumption of petroleum products has dramatically increased at a high rate of growth, secondly the oil production/reserves ratio is relatively high in Egypt comparing to a country which has a huge amount of oil reserves, and finally the oil sector has contributed fairly well to the Egyptian economy.

Considering the above three facts taking into consideration the uncertainty of oil discovery with no further substantial gains in the terms of trade due to oil price increase, in this case, it can be anticipated not only the effects of the oil sector to fall but also Egypt can be expected to be a net oil importer in the very near future. Therefore, the study in Chapter (7), has investigated both oil demand and oil supply sides in Egypt in order to determine the main factors affect them and which in turn affect the role of the oil sector in the economy in an attempt to reach some policy recommendations which might help policy makers in planning and controlling petroleum activities in Egypt in such a way that their contributions can be maximized.

On the demand side, the analysis of the demand for petroleum products in Egypt has depended on a simple demand model and therefore, policy actions should be proposed with caution. The results have indicated that price elasticities for petroleum products are all consistent with economic theory. The long-run price elasticities on disaggregate level are ranging form - 0.06 in the case of Fuel oil to - 2.11 in the case of Gasoline. The very low price elasticity in the case of Fuel oil may be explained by the artificial value of its price due to subsidy system where its price is highly subsidized. Fuel oil price also showed little variation if not any over the period of the study or even until 1983. So price response would not be clear when the other factors are considered, in particular the price of Fuel oil is probably a small proportion of total costs, in addition, electricity generation which represents the main consumer of Fuel oil, is geared to demand which presumably was growing, and public sector industries do not adopt a profit criterion and are less sensitive to unit cost changes. On the other hand, the long-run income elasticities for petroleum products are very low. This is an unexpected result because petroleum products are considered to be superior fuels in Egypt. Since R^2 for petroleum products models are quite high ranging from 0.9 in the case of Fuel oil to 0.99 in the case of LPG and Gas oil reflecting the goodness of fit of the models, the low elasticities could be attributable to the very low prices of petroleum products in Egypt due to subsidy system and which in turn affected the performance of the models. The income elasticity for Diesel oil gave the wrong negative sign reflecting that Diesel oil is an inferior good because of the existence of substitutes such as Gas oil.

On aggregate level, price and income elasticities are quite low although price elasticity is relatively higher, and they are - 0.503 and 0.134 respectively.

At any rate, the results show that price elasticities for petroleum products give reasonable evidence for the influence of prices on petroleum products consumption, although the short-run effects are small. Also, it can be concluded that the low elasticities mean that petroleum products are necessary goods for the economy. It can be also explained to some extent by the very low artificial values of some Fuels prices such as Fuel oil since it is highly subsidized.

The simulation exercise has been carried out using three different increases in petroleum products prices 10%, 20% and 30%. The results show that a 10% increase led to a reduction in domestic consumption of petroleum products ranging from 0.3% in the case of Fuel oil and 1.7% in the case of Diesel oil to 9.5% in the case of Gasoline. While a 20% price increase led to a reduction in domestic consumption ranging from 0.64% in the case of Fuel oil to 15.43% in the case of Gasoline. Finally, a 30% price increase led to a reduction in domestic consumption ranging from 1% in the case of Fuel oil to 21.14% in the case of Gasoline.

On aggregate level, a 10%, 20% and 30% increase in the average weighted price of petroleum products led to a reduction in total consumption of petroleum products by 5%, 10% and 14.5% respectively.

In order to examine the effects of petroleum products prices increases on macro-economic aggregates mainly national income and its components, the macro-econometric model developed in Chapter (6) has been used. In this model, oil exports have been assumed to be exogenous in order to examine the impact multiplier of oil exports on the macro-economy. Therefore, in order to investigate the effects of price increases on the macro-economic aggregates, a conjunction between the demand model for petroleum products and the macro-econometric model has been made by developing an econometric model for oil exports in Egypt.

The results show that the increases in petroleum products prices by 10%, 20% and 30% led to increases in gross national product by 2.13%, 4.26% and 6.3% respectively on its level in 1981. These increases in petroleum products prices led also to increases in all national income components.

It is noteworthy that although direct effects (i.e. the effects on domestic consumption of petroleum products) and indirect effects (i.e. the effects on macro-economic aggregates) of prices increases have been examined, these effects do not include the effects of the supply side and they do not include the effects on the other variables in the economy such as the impact on other commodities prices, on income distribution, on real wages, and on other sectors which use petroleum products as inputs.

It could be concluded, from the previous results that reconsidering the domestic pricing policy of oil in Egypt and raising domestic prices of petroleum products is very crucial in order to decrease and rationalize domestic consumption of petroleum products in particular the analysis of the subsidy system of petroleum products in Egypt has revealed that the system has not achieved its main goals.

Examining the main determinants of oil supply in Egypt, it seems very important to intensify investment in oil exploration activities in order to secure and increase oil reserves and which in turn lead to secure oil supply. Also, it seems reasonable that the relatively optimal policy of oil production in a country at a stage of rebuilding and developing her economy such as Egypt is that policy which produces on a level sufficient to be exchanged for a financial resource and which in turn could be invested in capital formation and thus developing the basic productive sectors. Such policy is, thus, taking account of future generations by directing oil revenues to future welfare through investment channels.

Also a national comprehensive and consistent energy plan is needed. Such plan should take into account the possibility of substitution between different sources of energy.

Also natural gas as a good substitute for some of petroleum products should be considered in particular at the present time, the production potential of natural gas is greater than the demand. However, studying the different aspects affecting the natural gas in Egypt and the government policy in this field is beyond this study and therefore it is left for further research.

Appendix (A)

Social Accounting Matrix of Egypt, 1977

(in million LE)

	1 Agriculture	2 Construction	3 Heavy Industry	4 Light Industry	5 Transportation
1.Agriculture	474.22	0.0	3.39	1039.70	8.71
2.Construction	.60	13.21	1.63	4.36	10.39
3.Heavy Industry	14.34	96.20	157.83	91.59	1.61
4.Light Industry	7.31	134.21	19.74	592.39	20.26
5.Transportation	2.51	5.00	6.11	23.16	5.34
6.Rest of Economy	24.66	215.39	36.86	152.50	43.87
7.Suez	0.0	0.0	0.0	0.0	0.0
8.Oil Extraction	.17	18.11	11.26	8.28	0.0
9.Oil Refining	9.72	9.66	39.32	20.95	22.0
10.Other Energy	.16	2.07	20.65	16.39	5.67
11. (1-10)	533.69	493.85	296.79	1949.32	117.85
12.H.H. Wage Income		405.74	124.87	581.53	123.24
13.H.H.Profit Income		295.89	32.76	259.03	13.14
14.Agricultural Income	1581.48				
15.Total Private Income (12-14)	1581.48	701.63	157.63	840.56	136.38
16.Government Income	142.20	78.65	139.67	481.09	205.94
17.Gross Savings					
18.Imports	83.25	91.66	114.42	427.69	49.51
19.Producer/ Consumer Subsidy	-46.03			-299.24	-15.35
20.Indirect Taxes			77.18	257.28	
21.Direct Taxes					
22.Total Gross Output	2294.59	1365.79	785.69	3656.70	494.33

Appendix (A) Continued

Social Accounting Matrix of Egypt, 1977

(in million LE)

	6 Rest of Economy	7 Suez	8 Oil Extraction	9 Oil Refining	10 Other Energy	11 (1-10)
1.Agriculture	86.72	0.0	0.0	0.0	0.0	1612.74
2.Construction	13.32	0.0	.54	2.06	.35	46.46
3.Heavy Industry	86.38	.64	5.27	2.86	.14	456.86
4.Light Industry	214.35	4.06	6.36	2.22	.73	1001.63
5.Transportation	163.04	.39	.71	.21	21.11	208.58
6.Rest of Economy	216.04	2.44	4.63	23.32	3.10	722.81
7.Suez	7.53	0.0	0.0	0.0	0.0	7.53
8.Oil Extraction	.67	0.0	.23	102.94	0.0	141.66
9.Oil Refining	69.48	1.68	4.55	12.94	8.97	199.27
10.Other Energy	20.27	.36	.68	1.09	0.0	67.34
11. (1-10)	877.80	9.57	22.97	147.64	15.40	4464.88
12.H.H. Wage Income	1384.25	17.59	10.09	10.88	21.59	2679.78
13.H.H.Profit Income	812.09	0.0	34.53	11.10	11.65	1470.19
14.Agricultural Income						1581.48
15.Total Private Income (12-14)	2196.34	17.59	44.52	21.98	33.24	5731.45
16.Government Income	110.74	158.24	157.26	50.53	49.77	1574.09
17.Gross Savings						
18.Imports	327.04	0.0	7.24	58.38	8.41	1167.60
19.Producer/ Consumer Subsidy	-15.35			-7.67		-383.64
20.Indirect Taxes	463.11		34.3	17.15	8.58	857.60
21.Direct Taxes						
22.Total Gross Output	3959.68	185.40	266.39	288.01	115.40	13411.98

Appendix (A) Continued

Social Accounting Matrix of Egypt, 1977

(in million LE)

	12 Private Consumption	13 Government Expenditures	14 Gross Fixed Investment	15 Stock Changes	16 Total Exports
1.Agriculture	933.89	58.63	.18	18.97	238.88
2.Construction	156.77	75.80	1086.76	0.0	0.0
3.Heavy Industry	128.84	38.61	74.49	39.12	47.77
4.Light Industry	1874.08	144.83	288.77	172.23	217.56
5.Transportation	186.51	28.53	0.0	0.0	70.71
6.Rest of Economy	1133.01	1195.40	319.20	43.6	545.66
7.Suez	0.0	0.0	0.0	0.0	177.87
8.Oil Extraction	0.0	0.0	0.0	5.22	119.51
9.Oil Refining	53.61	24.43	0.0	1.46	52.04
10.Other Energy	38.29	9.77	0.0	0.0	0.0
11. (1-10)	4505.00	1576.00	1769.40	280.60	1470.00
12.H.H. Wage Income					300.00
13.H.H.Profit Income					
14.Agricultural Income					
15.Total Private Income (12-14)					
16.Government Income					
17.Gross Savings	1469.41	529.09			490.00
18.Imports			438.50		
19.Producer/ Consumer Subsidy	-188.96	572.60			
20.Indirect Taxes					
21.Direct Taxes	246.00				
22.Total Gross Output	6031.45	2677.69	2207.90	280.60	2260.00

2488.50

Appendix (A) Continued

Social Accounting Matrix of Egypt, 1977

(in million LE)

	17 Competitive Imports	18 Indirect Taxes	19 Direct Taxes	20 Total Gross Output
1.Agriculture	-568.70			2294.59
2.Construction	0.0			1365.79
3.Heavy Industry	0.0			785.69
4.Light Industry	-42.4			3656.70
5.Transportation	0.0			494.33
6.Rest of Economy	0.0			3959.68
7.Suez	0.0			185.40
8.Oil Extraction	0.0			266.39
9.Oil Refining	-42.8			288.01
10.Other Energy				115.40
11. (1-10)	-653.90			13411.98
12.H.H. Wage Income				2979.78
13.H.H.Profit Income				1470.19
14.Agricultural Income				1581.48
15.Total Private Income (12-14)				6031.45
16.Government Income		857.60	246.00	2677.69
17.Gross Savings				2488.50
18.Imports	653.90			2260.00
19.Producer/ Consumer Subsidy				0.0
20.Indirect Taxes				857.60
21.Direct Taxes				246.00
22.Total Gross Output	0.0	857.60	246.00	27973.22

Appendix (A) Continued

Social Accounting Matrix of Egypt, 1979 (in million LE)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(1-10)	Private Consump- tion	Govern. Consump- tion	Gross Fixed Investment	Stock Changes	Exports	Total Final Demand	Total Output
(1) Agriculture	823453.8	-	7131.5	966820	28395.4	327699.3	-	-	-	-	2153500	1031500	75800	0	113700	366300	1587300	3740800
(2) Construction	702.5	189.1	2531.8	7802.9	25173	48465.5	-	6473.9	8403	571.3	106000	297000	75000	1513000	0	0	1885000	1991000
(3) Heavy Industry	15471.8	80543.7	252644.3	153500.5	3984.8	160857.2	733.3	70489.9	9190.8	260.4	747715	79785	36200	20000	3400	85700	225085	972800
(4) Light Industry	27808.2	109323.6	24420.8	827305.8	36166.2	672159.5	4654.2	56750.9	4675.3	609.9	1596093	2496520	182800	301000	235900	282800	3499020	5095116
(5) Transportation	1995.6	2501.3	6111	26467.8	6553.5	320232.1	454.7	4898.5	551	2245.3	372300	116800	29200	90000	0	205700	441700	814000
(6) Rest of Economy	29835.9	170511.4	58361.2	256559.1	99388	772901.5	2805	48376.6	96070.1	5191.2	1540000	2407800	1389900	296000	0	375100	4468800	6008800
(7) Suez	-	-	-	419.7	14900	-	-	-	-	-	14900	0	0	0	0	412100	412100	427000
(8) Oil Extraction	133.8	8458	10892.4	8058	-	1185.8	-	1944	92817	-	123489	0	0	0	64978	1729000	1793978	1917467
(9) Oil Refining	10540.6	5887.8	49586.5	27301.7	42023.6	70338.2	1931.1	38350	40431.4	11265.9	297600	51247	34100	0	2000	286600	373947	671547
(10)Electricity	102.8	5685.1	15543.5	14750.1	6682.2	32832	421.7	3868.2	2170.4	-	76900	35925	23900	0	0	0	59825	136725
Total Direct Inputs	910045	383100	427223	2278087	261442	2251998	11000	231152	254309	20144	7028500	6516577	1846900	2220000	419978	3743300	14746755	21775255
Imports	141655	599900	247580	1479682	69558	328102	-	19846	133877	14300	3034500	1705400	232900	1480000	0	0	3418300	6452800
Total Intermediate	1051700	983000	674803	3757769	331000	2580100	11000	250998	388186	34444	10063000	8221977	2079800	3700000	419978	3743300	18165055	28228055
Value Added	2689100	1008000	297997	1337347	483000	3428700	416000	1666469	283361	102281	11712255	0	0	0	0	0	0	11712255
Total Inputs	3740800	1991000	972800	5095116	814000	6008800	427000	1917467	671547	136725	21775255	8221977	2079800	3700000	419978	3743300	18165055	39940310

Appendix (B)

	CP	CG	IA	II	IS	K	I
1962	19.66072	4.41071	1.32143	1.69643	2.32143	0.00000	5.33929
1963	20.18966	5.48276	1.75862	2.51724	2.15517	0.00000	6.43103
1964	20.11290	6.48387	1.43548	2.54839	1.79032	0.00000	5.77419
1965	22.50769	6.72308	1.26615	2.60000	1.95385	0.35385	6.17385
1966	23.62687	7.19403	1.22687	2.56716	1.56716	1.02985	6.39104
1967	23.32857	6.97143	0.90000	2.00000	1.28571	0.38571	4.57143
1968	24.48611	7.80556	0.94444	1.88889	1.80556	0.69444	5.33333
1969	24.75343	8.83562	0.83973	2.10959	1.84932	-0.20548	4.59315
1970	24.55696	9.07595	0.67468	2.00000	1.82278	0.83544	5.33291
1971	26.15190	10.05063	0.55696	2.17722	1.94937	1.03797	5.72152
1972	26.95181	10.90361	0.66265	2.21687	2.00000	0.74699	5.62651
1973	25.98889	11.33333	0.64444	2.11111	2.38889	0.44444	5.58889
1974	29.29592	11.23469	0.55102	3.13265	3.17347	0.91837	7.77551
1975	32.93000	12.13000	0.95000	4.93000	6.67000	1.00000	13.55000
1976	32.19167	13.09167	0.82500	5.86667	5.39167	1.62500	13.70833
1977	33.91034	11.70345	1.00966	6.37241	5.29655	3.86897	16.54759
1978	39.99363	11.72611	1.21847	8.28662	7.17197	2.64968	19.32675
1979	46.86413	11.19022	1.45652	8.54348	8.17935	2.44565	20.62500
1980	53.96954	13.69036	1.77157	11.84264	11.77665	2.46701	27.85787
1981	68.05189	16.17924	2.56132	7.64623	16.67924	0.47170	27.35849

	MC	MR	MI	MS	M	X	E	N
1962	2.39286	1.60714	1.37500	0.42857	5.80357	0.26964	3.99821	4.26786
1963	3.06897	2.05172	1.75862	0.39655	7.27586	0.38621	5.06207	5.44828
1964	3.01613	1.88710	1.77419	1.25806	7.93548	0.35806	5.41613	5.77419
1965	2.89231	1.89231	1.46154	0.96923	7.21538	0.27692	6.04615	6.32308
1966	3.16418	2.00000	1.77612	1.01493	7.95522	0.22836	5.87612	6.10448
1967	2.72857	1.20000	0.98571	1.55714	6.47143	0.20143	5.92714	6.12857
1968	1.93056	1.11111	0.98611	2.15278	6.18056	0.20833	4.08333	4.29167
1969	1.61644	1.27397	0.91781	2.31507	6.12329	0.26027	4.94521	5.20548
1970	1.56962	1.35443	1.06329	2.93671	6.92405	0.39241	5.00000	5.39241
1971	2.15190	1.39241	1.12658	2.93671	7.60759	0.36709	5.22785	5.59494
1972	2.00000	1.37349	0.95181	3.49398	7.81928	0.21687	5.28916	5.50602
1973	1.97778	1.07778	1.01111	4.03333	8.10000	0.27778	5.62222	5.90000
1974	5.54082	2.32653	1.72449	4.64286	14.23469	0.74490	8.33673	9.08163
1975	8.30000	4.22000	3.22000	3.47000	19.21000	1.24000	8.24000	9.48000
1976	6.18333	2.76667	3.91667	1.89167	14.75833	2.10000	6.51667	8.61667
1977	5.72414	2.93793	4.61379	4.48276	17.75862	1.95862	10.26896	12.22759
1978	7.82166	3.14650	6.32484	3.82803	21.12102	2.36943	10.01911	12.38854
1979	7.32065	2.32065	4.95109	5.72283	20.31522	7.28804	10.38587	17.67391
1980	9.49746	3.04061	4.72081	8.89340	26.15228	10.88832	14.98477	25.87310
1981	15.76887	5.18868	8.22170	8.78302	37.96227	11.35849	15.93868	27.29717

Appendix (B) Continued

	QA	QI	QS	PMC	PMR	PMI	PMS
1962	7.12500	7.60714	13.25000	3.44186	1.94643	1.96643	0.51786
1963	7.75862	8.27586	12.81034	3.53488	2.01786	2.07143	0.52500
1964	8.53226	8.43548	13.45161	3.42222	2.54237	1.89831	0.50169
1965	9.15385	8.61539	14.24615	3.05882	1.69841	1.69841	0.48571
1966	9.10448	8.79105	14.70149	3.00000	1.59420	1.85507	0.47246
1967	8.97143	8.38571	14.07143	3.33929	1.47945	1.39726	0.45479
1968	9.25000	8.52778	13.66667	3.18644	1.14085	1.45070	0.47042
1969	10.00000	9.30137	14.20548	3.53333	1.35211	1.25352	0.53944
1970	9.78481	9.36709	14.10127	2.93333	1.40000	1.42667	0.53333
1971	10.30380	9.96203	14.60759	2.90909	1.78667	1.36000	0.53733
1972	11.24096	9.68675	15.24096	2.96203	1.72368	1.32895	0.55921
1973	11.80000	9.46667	17.22222	2.86585	1.41975	1.40741	0.52593
1974	13.06122	10.72449	19.04082	2.36264	0.98925	1.23656	0.46237
1975	14.68000	13.60000	22.28000	1.00000	1.00000	1.00000	1.00000
1976	14.53333	13.45833	23.38333	2.78182	0.68519	0.85185	0.85185
1977	14.05517	14.14483	23.75862	2.83871	0.66949	0.86441	0.88983
1978	14.56051	16.45223	26.44586	2.43478	0.66667	0.65185	0.74074
1979	13.75000	23.57065	28.44565	2.61184	0.72973	0.68243	0.80405
1980	14.77157	70.65482	31.94416	2.62842	0.80663	0.44199	0.79558
1981	18.35849	73.63207	42.87264	2.53465	0.91795	0.49744	0.76923

	Y	T	YD	Q	QD	POP	DF
1962	27.87500	3.82143	24.05357	27.60536	23.78393	27.30000	56.00000
1963	30.27586	4.68966	25.58621	29.88966	25.20000	28.00000	58.00000
1964	30.20968	5.11290	25.09678	29.85161	24.73871	29.00000	62.00000
1965	34.51231	5.26154	29.25077	34.23539	28.97385	29.40000	65.00000
1966	35.36119	6.34328	29.01791	35.13284	28.78955	30.00000	67.00000
1967	34.52857	6.04286	28.48572	34.32714	28.28429	31.00000	70.00000
1968	35.73611	5.75000	29.98611	35.52778	29.77778	32.00000	72.00000
1969	37.26439	6.17808	31.08630	37.00411	30.82603	33.00000	73.00000
1970	37.43418	6.63291	30.80127	37.04177	30.40886	33.33000	79.00000
1971	39.91140	7.13924	32.77216	39.54431	32.40507	34.00000	79.00000
1972	41.16867	7.03614	34.13253	40.95181	33.91566	35.00000	83.00000
1973	40.71111	6.84444	33.86667	40.43333	33.58889	36.00000	90.00000
1974	43.15306	6.96939	36.18367	42.40816	35.43877	36.40000	98.00000
1975	48.88000	9.48000	39.40000	47.64000	38.16000	37.23000	100.00000
1976	52.85000	10.42500	42.42500	50.75000	40.32500	38.00000	120.00000
1977	56.63034	12.93793	43.69241	54.67172	41.73379	39.00000	145.00000
1978	62.31401	12.95541	49.35860	59.94459	46.98917	40.00000	157.00000
1979	76.03805	13.81522	62.22283	68.75001	54.93479	41.00000	184.00000
1980	95.23858	21.20812	74.03046	84.35026	63.14214	42.00000	197.00000
1981	100.92453	25.84906	75.07548	89.56604	63.71698	43.00000	212.00000

Appendix (B) Continued

The Annual Growth Rates of

Value Added (1970/71 - 1979/80)

	Oil Sector	Agriculture	Industry	Services
1970/1	-14.23	10.4	4.7	6.4
1971/2	-27.4	9.2	-3.8	3.2
1972/3	44.2	13.8	6.4	29.8
1973/4	134.7	20.5	28	14.7
1974/5	34.2	14.7	29.7	19
1975/6	112.8	19	3	7.3
1976/7	47.6	2.5	13.4	14
1977/8	34	15.8	12.1	15.4
1978/9	120	61	19.3	23
1979/80	58.6	3.3	17.2	20.5

Appendix (C)

	Q1	Q2	Q3	Q4	Q5	Q6	Q
1963	9.57143	94.39286	1.46429	31.00000	27.42857	8.39286	178.32143
1964	9.65517	99.96552	1.82759	31.17241	29.00000	8.34483	186.27586
1965	9.76190	102.38095	2.00680	31.56463	29.79592	8.43537	194.86395
1966	8.56667	104.16666	2.46667	31.96667	30.80000	8.13333	197.06667
1967	11.32258	97.38710	2.19355	28.16129	30.93548	7.16129	160.32259
1968	12.53125	100.59375	2.53125	23.65625	30.90625	6.84375	177.18750
1969	13.51515	90.78788	2.51515	23.87879	29.06061	6.54545	125.45454
1970	15.73574	91.26126	3.24324	24.62462	29.87988	5.43544	177.74776
1971	16.67647	94.26471	3.50000	27.64706	30.17647	4.76471	182.82353
1972	14.00000	91.48572	3.88571	28.08571	30.11429	5.02857	179.02856
1973	14.75000	91.63889	4.25000	28.69444	29.61111	4.97222	184.02777
1974	15.93406	91.20879	4.36813	30.46703	28.98351	4.61538	182.99449
1975	18.16216	98.35135	4.83784	32.10811	31.86486	4.21622	206.10811
1976	19.63158	105.57895	5.57895	33.02632	34.92105	3.94737	229.47368
1977	21.82051	110.05128	6.35897	33.46154	37.97436	3.82051	243.53847
1978	24.42500	104.55000	7.40000	34.50000	42.65000	3.82500	236.70000
1979	24.75610	102.24390	8.17073	35.36585	48.12195	3.63415	258.07318
1980	27.57143	123.14286	9.09524	35.78571	54.28571	3.42857	269.59525
1981	29.65116	136.23256	10.16279	37.58139	66.83721	2.44186	304.65115
1982	32.05817	146.48769	10.64877	39.86577	71.16331	2.46085	324.38480

	P1	P2	P3	P4	P5	P6	P
1963	125.00000	13.03571	64.28571	33.92857	32.14286	26.78572	26.24063
1964	118.64407	13.05085	64.40678	32.20339	30.50848	25.42373	25.06300
1965	111.11111	12.22222	57.14286	30.15873	28.57143	23.80952	22.86086
1966	111.59420	11.15942	63.76812	27.53623	43.76812	26.08686	23.93199
1967	106.84931	10.54795	60.27397	35.61644	41.36986	24.65753	30.11827
1968	108.45071	10.14085	61.97183	47.88733	42.53521	34.64789	29.46345
1969	109.85916	10.56338	61.97183	47.88733	42.53521	34.64789	41.49738
1970	105.33334	10.00000	58.66667	37.86666	40.26667	32.80000	28.54764
1971	108.00000	10.00000	58.66667	37.86666	40.26667	32.80000	29.35798
1972	113.15790	9.86842	57.89474	37.36842	39.73684	32.36842	28.60395
1973	115.06172	9.25926	54.32099	35.06173	37.28395	30.37037	27.37433
1974	100.21505	8.06452	55.91398	30.53763	32.47312	26.45161	24.97500
1975	99.00000	7.50000	52.00000	32.20000	30.20000	24.60000	23.71171
1976	91.66666	6.94444	48.14815	29.81481	27.96296	22.77778	21.14598
1977	83.89831	6.35593	44.06780	27.28814	25.59322	20.84746	19.60695
1978	73.33333	5.55556	38.51852	23.85185	22.37037	22.51852	19.09656
1979	87.83784	5.06757	35.13514	25.54054	20.40541	20.54054	19.14026
1980	92.81768	4.14365	28.72928	20.88398	20.05525	16.79558	19.37839
1981	86.15385	3.84615	26.66667	19.38461	18.61538	15.58974	17.59491
1982	85.44601	3.52113	24.41315	17.74648	17.04225	14.27230	16.86391

Appendix (C) Continued

	POP	WPI	T
1963	28.00000	0.56000	1.00000
1964	29.00000	0.59000	2.00000
1965	29.40000	0.63000	3.00000
1966	30.00000	0.69000	4.00000
1967	31.00000	0.73000	5.00000
1968	32.00000	0.71000	6.00000
1969	33.00000	0.71000	7.00000
1970	33.30000	0.75000	8.00000
1971	34.00000	0.75000	9.00000
1972	35.00000	0.76000	10.00000
1973	36.00000	0.81000	11.00000
1974	36.40000	0.93000	12.00000
1975	37.00000	1.00000	13.00000
1976	38.00000	1.08000	14.00000
1977	39.00000	1.18000	15.00000
1978	40.00000	1.35000	16.00000
1979	41.00000	1.48000	17.00000
1980	42.00000	1.81000	18.00000
1981	43.00000	1.95000	19.00000
1982	44.70000	2.13000	20.00000

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