A PRODUCTION APPROACH TO REGIONAL ECONOMIC INTEGRATION

By

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ABSTRACT

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To the extent that economic integration through the mobility of factors of production offers advantages in terms of economies of scale and external economies, by virtue of increasing the effective size of the integrated market, it may accelerate the process of economic development.

The major objective of this study, therefore, was to explore the possibility of undertaking this new avenue to development when applied to some Arab countries. The countries chosen were Egypt and Libya, whose two economies are highly complementary. Libya enjoys a large surplus of financial capital which cannot be absorbed domestically due to many constraints, of which the most important is the scarcity of skilled and unskilled labor. By contrast, there exists in the Egyptian economy a widespread labor redundancy coupled with an acute shortage of capital.

In the course of this investigation, the theoretical foundation of economic integration was discussed. To build the case for the mobility of capital and labor, the economic features of Libya and Egypt were analyzed. Against this background, the major hypothesis that was tested is that economic integration between the two countries is likely to be beneficial. The economic gain would

be due to higher levels of productivity of at least some of the factors of production and a higher level of output.

To accomplish these objectives, both theoretical and empirical analysis was employed. To evaluate the technical relationship between inputs and outputs, a variety of Cobb-Douglas production functions were estimated for each economy, as well as for the integrated economy. The results were used to estimate the productivity of capital and labor and their marginal rates of substitution. To estimate the elasticity of substitution between inputs, a transcendental logarithmic (translog) function was utilized. Finally, a general equilibrium approach was adopted to evaluate the "working" of the integrated economy. How will resources be allocated "efficiently"? And what is the optimal choice of output for the combined economies?

The general conclusion of this study was that there is ample theoretical and practical justification for the formation of some sort of economic integration between Egypt and Libya. The reallocation of resources will lead to higher productivity of Libyan capital, and higher productivity of Egyptian labor. There will be a significant increase in the output of each economy as measured by gross domestic product, and of the integrated economy.

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A final word must be left for the joy of my life, my daughter,

Yasmine. Although she claims no contribution to the thesis -- actually her cuteness was in many instances a pleasurable distraction -- her presence was the biggest motivation for me to pursue this goal, as well as many others.

To my parents

Abdussalam El-Tarhouni
Mabroukah El-Griani

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Introduction

This study is an attempt to investigate the possibility of economic integration between Libya and Egypt. The importance of this study stems first from the high priority attached to the goal of economic development as stated in the development plans of both countries. Their experience indicates that the goals set forth have not been achieved, at least at the desirable rate. Second, both countries are of small economic size, particularly Libya. The limited size of the domestic market tends to place a more severe constraint on development after the initial phases of "easy-import substitution" is completed. Third, the two economies are faced with basic structural "deficiencies" in their initial factor endowments. Specifically, Libya enjoys a large surplus of financial capital which cannot be absorbed domestically due to many constraints, of which the most important is the scarcity of skilled and unskilled labor. By contrast, there exists in the Egyptian economy a widespread labor redundancy coupled with acute shortage of capital.

To the extent that economic integration through the mobility of factors of production offers advantages in terms of economies of scale and external economies, by virtue of increasing the effective size of the integrated market, it may accelerate the process of economic development. These effects of economic integration, however, must be considered in the light of fragmentation and disintegration, some of which may be derived from the process of economic integration itself.

The problem with which this study deals can be stated as follows: Are there viable economic reasons for integrating those two economies? And if so, through what mechanism can integration be achieved? What are the likely gains, and is it possible to estimate the magnitude of such economic gain?

Our main hypothesis is that economic integration between Libya and Egypt is likely to be beneficial. This economic gain would be more likely to be due to the "dynamic effects" rather than to the "static effects." Specifically, economic integration will lead to a higher level of productivity of at least some of the factors of production and a higher level of output.

The objectives of this study are 1) to build a case for economic integration between Egypt and Libya. This can be accomplished by demonstrating the lopsided nature of each economy and the resultant constraints. Specifically, the goal is to prove the existence of capital surplus and labor redundancy in Libya and Egypt respectively. The aim is to show, through this analysis, that integration is the most viable alternative for fostering economic development for both economies. 2) To estimate and analyze the productivity of capital and labor in each economy. The purpose of the analysis will be to test the two following hypotheses: a) that labor productivity in Egypt is "low" relative to labor productivity in Libya; and b) that the productivity of capital in Egypt is high relative to the productivity of capital in Libya. 3) To demonstrate the gains from economic integration in terms of higher productivity of inputs and higher level of output for the integrated economy.

To accomplish the objective of this study, both theoretical and empirical analysis will be employed. The performance of both economies will be evaluated for the period extending from 1962 to 1977. The choice of this period is based on the availability of data and the fact that it encompasses the "major" changes that affected both economies in the past. To evaluate the technical relationship between inputs and outputs, a Cobb-Douglas production function will be estimated for each economy. The results will be used to estimate the productivity of capital and labor and their marginal rates of substitution. The CD production function will also be used to estimate the production relationships in the integrated economy. To estimate the elasticity of substitution between inputs, a transcendental logarithmic (translog) function will be utilized. Its choice is based on the fact that it does not impose a priori constraints on the elasticity of substitution among factors of production. A general equilibrium approach will be adopted to evaluate the "working" of the integrated economy. How will resources be allocated "efficiently"? And what is the optimal choice of output for the two combined economies?

This study is presented in seven chapters.

Chapter I provides a critical evaluation of the literature of economic integration from the viewpoint of its relevance to LDC's. It is intended to point out the analytical and empirical limitations of the static approach in studying economic integration.

Chapter II provides the theoretical framework of analysis for the following chapters. CD and translog production functions, and

their use in deriving approximation to the relationships of substitution and productivity of inputs are presented.

Chapter III provides an evaluation of the concept of capital surplus and demonstrates its magnitude in the Libyan economy. The limited absorptive capacity will be studied and various limitations and constraints facing the domestic market will be explored.

Chapter IV examines the Egyptian labor force, its growth and participation rates, unemployment, and finally, the labor surplus in agriculture.

In Chapter V, estimates of CD for Egypt are presented. The estimates are used for calculating input productivities and their marginal rates of substitution. The results are used to test the hypothesis of low labor productivity. Assuming the prevailing production technology is the same across Egypt, estimates of elasticities of substitution among inputs are presented. The results are used to estimate the impact of resource allocation both from and to Libya. Finally, the allocative efficiency of Egyptian labor is evaluated.

In Chapter VI, estimates of CD for Libya are presented. The estimates are used for calculating input productivities and their marginal rates of substitution. The results are used to test the hypothesis of low productivity of capital. Assuming the prevailing technology is the same across Libya, estimates of elasticities of substitution among inputs are presented. The results are used to evaluate the impact of resource transfer both from and to Egypt.

Chapter VII provides the results of the pooled production function for Egypt and Libya. The hypothesis of higher levels of produc-

tivities within the integrated economy is tested. The gains from integration are evaluated in terms of efficient allocation of resources and higher levels of output.

Chapter 1

Critical Review of the Literature

The literature on economic integration is a vast one. Fields such as trade, development, and economic theory are replete with reference to the term "economic integration," but there seems to be little agreement among the users of the term as to just what it means.

In this chapter, I shall trace the evolution of the concept, present the various definitions it is given in the literature, and explore the different types of integration involved. I will also consider the issues pertaining to the measurement of integration.

A. The Evolution of the Concept

The word "integration," taken from the Latin INTEGRATIO, was mostly used in the sense of "renovation." The Oxford English Dictionary gives 1620 as the date for the first use in print of this word, in the sense of "combining parts into a whole." Fritz Machlup discloses that the term "integration" in its new economic meaning (Machlup, 1971) made its appearance between 1939 and 1942.

Machlup traces the origin of the term and relates it to as far back as the days of Adam Smith, Sir William Petty, David Ricardo, and

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In Economics, the word was first employed in industrial organization to refer to combinations of business firms through agreements, cartels, concerns, trusts, and mergers. In the sense of combining separate economies into large economic regions, the word "integration" has a very short history.

others. The early writers were expounding the advantages of extending the area of free trade during the period 1690-1879. The term evolved more in the theory of international trade by writers such as Chalres Bastable, Frank Graham, and Francis Y. Edgeworth. The literature during that period centered around issues such as the impact of factor prices and incomes on factor endowments and mobility. However, it was not until World War II and later that economic integration as a subject of interest developed. This was because after the war several plans for regional economic integration and even worldwide integration materialized.

B. Definition of Integration

Myrdal regards integration as a social and economic process that destroys barriers (social and economic) between the participants of economic activities within as well as between nations. Myrdal writes, "The economy is not integrated unless all avenues are open to everybody and the remunerations paid for productive services are equal, regardless of racial, social and cultural differences" (Myrdal, 1956, p. 11).

Most economists, however, consider only international aspects of economic integration, including the relevant aspects of international cooperation. Professor Triffin, for example, considers the activities of OECD (The Organization for European Cooperation and Development) and EPU (The European Payments Union) as forms of economic integration (Triffin, 1956, p. 618). A somewhat more restricted definition is given, along similar lines, by F. Hartog, who defines integration as a "rather advanced type of cooperation, as distinct from the term 'harmonization,'

which refers to mutual consultation on important issues of economic policy" (Hartog, 1953, p. 165). Essentially the same interpretation is furnished by Robert Marjolin who maintains that "any process which brings about a greater degree of unity" can rightly be called integration (Marjolin, 1953, p. 165). Professor Tinbergen considers integration as "the creation of the most desirable structure of international economy removing artificial hindrances to the optimal operation and introducing deliberately all desirable elements of coordination or unification" (Tinbergen, 1954, p. 95). This concept of optimization introduced by him later became the basis for measurement of integration.

Kindleberger and Myrdal point to the importance of social factors in destroying barriers between communities, races, and social strata. Social integration and the concomitant equalization of factor prices are necessary for total integration. Yet the removal of trade barriers in the case of customs unions, for example, constitutes an act of economic integration even in the absence of developments in the social field. Bel Balassa (1961, p. 63) further claims:

> Although social integration gains in importance as the unification of national economies proceeds, it is not necessary for the lower forms of economic integration, and it need not be included in our definition.

Leaving the social factors out of the definition of economic integration later proved to be one of the central elements that hindered economic integration, especially in LDC's. Balassa agrees with the objections that have been raised regarding the inclusion of national integration in the concept. Those objections rested on the ground

that in the present day world, the problems relating to integration on the national and international level differ to a considerable degree. In the former case, the barriers between economic units are mainly of a social, educational or psychological character, and these obstacles may be stronger between various social strata of the same region than between regions.

One of the main instruments of national economic integration appears to be the creation of a strong national state. However, as Myrdal emphasized, the creation of a national state leads to artificial barriers between independent economies in the form of tariffs, quantitative trade and exchange restrictions, and impediments to the mobility of labor, capital, and entrepreneurs (Myrdal, 1956, p. 57). Furthermore, national economic policies, fiscal, social and monetary, represent another form of discrimination between economic units of independent countries. An offset is provided by international integration which leads to the elimination of some of the native aspects of national integration.

In view of this, Balassa excludes national integration from the concept and defines economic integration as "a process and state of affairs." He writes (Balassa, 1961, p. 4):

> Regarded as a process, it encompasses various measures abolishing discrimination between economic units belonging to different national states: viewed as a state of affairs, it can be represented by the absence of various forms of discrimination between national economies.

Machlup points out that users are virtually unanimous on the question that integration can be understood either as a process or as a state

of affairs reached by that process. Whether that state has to be a terminal point or an intermediate point in the process is not always clear (Machlup, 1971, p. 5), but this ambiguity can be taken care of by distinguishing between complete and incomplete integration. More difficult is the question of what is to be integrated--people, areas, markets, or policies? The most important questions thus asked are: (1) what is the substance, what are the essential features of such integration; and (2) by what indications can one decide whether there is a satisfactory process at work or a satisfactory outcome?

Users of the term may agree on what the substance is and yet disagree on how one can ascertain progress. Conversely, there might be agreement on possible indicators but no agreement on the essentials. Machlup gives the following example: there is fundamental disagreement on the relation between economic integration and equalization of incomes (or of the prices of productive services) in different areas. (Some writers regard equalization as the essence of integration; others, as the main target; others as an indicator; and others as merely incidental or even unrelated to economic integration).

Balassa wants his previous definition to be restricted to the state of affairs of different nations joining in a regional group or bloc. One can question this restriction as unnecessary and uneconomical as well because the economics of the matter is the same whether it is different provinces of a state that become "more integrated," or different nations within a bloc or different blocs in the world as a whole. One can easily differentiate by speaking of national (inter-

provincial), regional (multinational), and worldwide (global, universal) integration (Machlup, 1971, p. 65). Furthermore, one can speak of sectoral, as distinguished from general, integration when dealing with arrangements for coordination or unified management of particular sectors of two or more economies.

More recently, Balassa proposed that integration progresses through

1. freeing of barriers to trade (trade integration);
2. the liberalization of factor movements (factor integration);
3. the harmonization of national economic policies (policy integration); or
4. complete unification of these policies (total integration).

This demarcation of issues does not resolve the underlying issues, of course. To what extent does factor integration presuppose trade and factor integration? Also, does factor integration refer to all types of factors of production, and to what extent is this assumed to coexist with unrestricted movement of goods? It may be better to refer more specifically to integrated product, labor, and capital markets (Vajda, 1971).

Present day market economies are characterized by a considerable degree of state intervention. This renders <u>all</u> the previous definitions vulnerable as they derive from classical laissez-faire doctrines rather than present day markets and apply even less to developing and socialist countries.

Pinder emphasized <u>policy coordination</u> which he views as an

important element of integration. He proposed to define economic integration as "both the removal of discrimination as between the economic agents of the member countries and the formation and application of coordinated and common policies on a sufficient scale to ensure that major economic and welfare objectives are fulfilled" (Pinder, 1968, pp. 88-110).

The Hungarian economist Irma Vajda, while emphasizing the need for policy coordination, criticized the definition put forward by Pinder as too general. Vajda introduced the distinction between "market integration" and production and development integration. He defined "market integration" as "the guarantee of unhindered sale of each other's product within the framework of the social system of participating countries" (Vajda, 1971, p. 35). He defined the second as "raising to an international level of programming the production of those branches of industry which cannot be developed to an optimum size within national boundaries." Vajda thus distinguishes between trade integration through the removal of barriers of trade and integration through industrial programming on the regional (plurinational) level. This distinction is applicable to developed markets as well as to socialist, and to developing economies as well.

This review reveals a tendency to focus on economic integration

1. as it refers to the division of labor,
2. as it involves the mobility of goods or factors, or both, and
3. as it relates to discrimination or nondiscrimination in the treatment of goods and factors.

But it is difficult to find a definition of integration that applies to all types of economies. This difficulty, in my view, stems from a fundamentally wrong approach to the problem; namely, the tendency to separate the objectives of integration from the tools which are likely to be the most appropriate and effective in achieving them. The failure to realize this has led to more serious problems. The most serious is the omission of the differences that exist between different countries, in particular the differences between DC's and LDC's.

C. Types of Integration

Balassa summarized the various stages of economic cooperation and integration as follows:

1. Free trade area where particpating countries abolish tariffs and quantitative restrictions on trade in local products between themselves, but each country retains its own tariff against non-members.

2. The customs unions which, in addition to free trade between members, includes imposition of the same external tariffs against non-members.

3. The common market, which is a more advanced stage of integration where restrictions on factor movements within the area are also abolished.

4. The supranational union, the most advanced form of integration, where the governments of participating countries relinquish their sovereignty over economic and social policies to a supranational authority (Balassa, 1961, pp. 1-2). Following the classical theory of international trade, it was assumed that a customs union

will always raise world welfare because it means a free trade area without any restrictions.

Viner, however, demonstrated that this was not always the case by introducing the concepts of trade creation and trade diversion (Viner, 1950, p. 44). This can be shown as follows: consider a three country world in which countries A and B form a customs union which means country C will be subject to a common external tariff. This action has three effects.

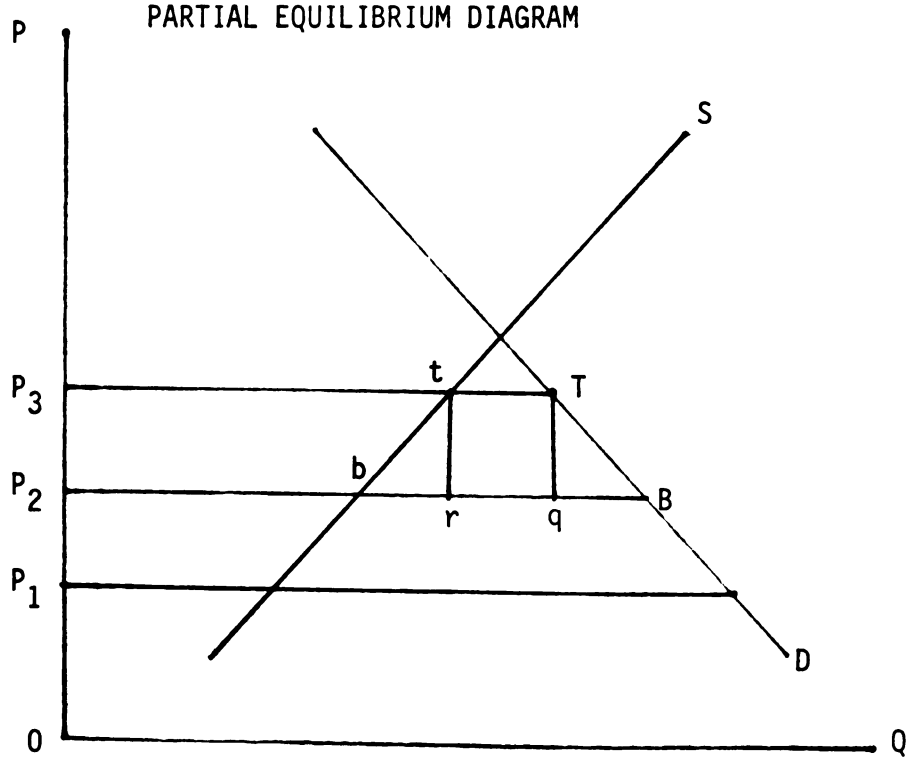
First, with respect to products in which A and B are competitive, the elimination of tariffs between them causes the replacement of some high-cost production by imports from the partner country. This effect, known as trade creation, is favorable to world welfare since it rationally reorganizes production within the union.

Second, for products in which country C is competitive with one of the integrating countries, A or B begins to import from the other what it earlier imported from C. If C is the most efficient producer it would be the major supplier for as long as its product received the same tariff treatment as those of its competitor. But the tariff discrimination induces diversion of trade away from C toward a member country. This effect, known as trade diversion (Kreinin, 1975, p. 309), is unfavorable because it reorganizes world production less efficiently. Production shifts from the most efficient location in C to less efficient ones inside the union.

Finally, there is a favorable consumption effect, as consumers in each member state benefit from price reduction on imports from the partner country when intraunion tariffs are removed. Indeed,

Professor Kreinin argues that a net unfavorable production effect (when trade diversion exceeds creation) may be more than offset by the consumption effect, yielding a net gain in welfare. These three effects can be illustrated with the help of a partial equilibrium diagram.

FIGURE 1-1
PARTIAL EQUILIBRIUM DIAGRAM



op_1 = price under free trade
op_2 = price of customs union
p_1p_2 = tariff of the customs union on C products
tT = trade diversion
br = trade creation
q_B = consumption effect

Those effects constitute "static effects." "Dynamic effects," on the other hand, represent the expansion of the market size which enhances the production on a large scale. Furthermore, these effects concen-

trate on growth and development considerations. Unfortunately, the literature has little to give concerning these issues of dynamic effects.

D. Integration Schemes

1. Integration in developed countries

The EEC (European Economic Community) is by far the most developed scheme of economic integration in developed market economies. The original members of the EEC were Belgium, France, Germany, Italy, Luxembourg, and the Netherlands. The United Kingdom joined the EEC in 1974. Following the creation of the EEC, existing quantitative restrictions on intra-area trade were soon abolished, tariffs on intra-area trade reduced, and a common tariff on extra-area imports established. The volume of trade expanded dramatically following the abolishment of barriers of trade. Between 1959 and 1971, trade among original members increased sixfold, as against a fourfold increase in their total imports and exports. As a result, the share of intraEEC trade in the total rose from one-third in 1959 to one-half in 1971 (Balassa, 1961).

Balassa raises the question, to what extent the expansion of intraEEC trade represents trade creation (the replacement of domestic by partner country source of supply) or trade diversion (the replacement of foreign by partner country sources) and how these changes in trade flows affect the welfare of member and nonmember countries? He estimated trade creation and trade diversion in the EEC using two techniques: first, the traditional comparison of ex-post income

elasticities of import demand in intra-area and extra-area trade for periods preceding and following integration; and second, using input-output techniques.

Based on his estimate, he reached the conclusion that trade creation exceeded trade diversion several times. Balassa further concluded that trade creation has resulted largely from intra industry specialization in manufacturing which brings benefits through the exploitation of economies of scale which boosts economic growth in member countries, enabling them to attain the post-war reconstruction rates of growth.

While trade diversion has occurred in the case of foodstuffs, chemicals and simple manufactured goods, it has been offset by increased imports of machinery and equipment, which have been associated with the expansion of investment activity and the trend toward the purchase of more sophisticated machinery in the EEC.

The effects of the EEC on nonmember countries have been rather uneven. The main beneficiary has been the United States, which is the principal supplier of the sophisticated machinery and equipment demanded in the EEC countries. By contrast, developing and socialist countries have been adversely affected by trade diversion in food and in simple manufactured goods. In particular, the increasing barriers to food imports have penalized foreign suppliers.

Finally, Balassa stresses the point that, while the beneficial effects of integration on economic growth in the common market stem from "market integration" in manufactured goods, little progress has been made with regard to "production and development integration." This is seen in technologically sophisticated industries,

such as aircraft, space, computer and electronics, where efficiency operations are limited by the size of national markets (Balassa, 1961, p. 21).

Given the still unresolved problems of the EEC, it is necessary to harmonize a wide range of policies to achieve the goals envisaged for the community. A simple tariff removal is not sufficient. Harmonization of policies is needed in various fields, such as transportation, social security and monetary and fiscal policies relating to the free movement of capital and labor. The more recent developments, such as the oil price increases and the advent of floating rates, have shown a great resistance on the part of member states to relinquish the vital element of national sovereignty. The EEC experience shows that further harmonization will be perceived as in conflict with nationalistic values and considerations.

2. Integration in socialist countries.

The Council for Mutual Economic Assistance (CMEA) was established in 1949. The participating countries are: the USSR, Bulgaria, Hungary, Poland, Romania, Czechoslovakia, Albania, and the German Democratic Republic (GDP). Mongolia and Cuba recently joined while Albania has ceased participation. In 1959 these countries signed the formal charter of CMEA, which added to the original purpose of economic cooperation (as stated in the foundation declaration of 1949) the objections of speeding up economic and technical progress in (the member) countries and of industrializing the less developed countries (Article 1).

The resolution on "basic" principles of International Social-

ist Division of Labour adopted in 1962 called for a rational division of labor within the framework of long-term agreements calling for the coordination of national plans. This would eventually include coordinated multilateral plans aimed at such things as the working out of consolidated economic balances, and the "future creation of a communist world economy, directed according to a uniform plan." The coordination of national plans remained one of the key objections in the comprehensive program adopted in 1971. However, the document emphasized the primacy of national planning bodies in the process of cooperation and of national interest in intra CMEA specialization and made no mention of a common plan (Shaefer, 1972). This apparent change reflects the rejection of "establishing a unified planning organ" and of the idea of planning at the CMEA level.

Integration within the CMEA has a different character. Different stages of development and different mechanisms are inherent in socialist integration. For example, the socialist countries did not make use of such methods as the establishment of customs unions or free-trade zones, since these do not have the same role as the ones in western countries. On the other hand, the existence of social ownership of the means of production allows the introduction of such forms of integration based on the planned development of socialist economy, and following the activity of the socialist state and its economic organization (Maksimova, 1971). For that reason, integration in the CMEA started with higher and more complex forms: coordination of economic plans, and the creation of a mechanism for scientific, technical and production cooperations.

The joint efforts of the participating countries then would be undertaken to tackle major problems in the energy sphere, including atomic energy, the production of raw materials, and the establishment of electronic computer systems and a number of other branches of industry and cooperation of production.

During the years 1949 - 1973, the combined national income of the member countries increased eightfold and industrial production more than twelvefold (Maksimova, 1971, p. 35). The corresponding indices for the EEC Six over the same years were 3.6 times and 5.5 times, and for the EEC Nine it was threefold and fourfold respectively. Balassa contradicts those estimates. He writes (Balassa, 1961, p. 35):

> With the availability of assured market outlets, the trade of the CMEA countries has continued to grow. However, the rate of expansion has slowed down, and the share of intra-area trade has declined since the CMEA charter was signed. The average annual rate of growth of imports by CMEA countries, taken together, was 8.5 percent in the period 1959-71, as against 10.7 percent in 1953-59. The differences become larger if calculations are made in terms of constant prices and they cannot be fully accounted for by reference to the slowdown in the rate of economic growth. Thus, while the annual average rate of growth of the combined net material product of the CMEA countries fell from 10.3 percent in 1953-59 to 7.2 percent in 1959-70, the rate of growth on the volume of total imports declined from 12.3 to 8.2 percent.

The CMEA member countries attach much importance to commodity and money relations, to the development of trade, to the improvement of price systems, and to monetary-financial and credit relations, while paying particular attention to the coordination of plans and joint production, scientific and technical activity.

The efforts within the CMEA to exploit the advantages provided

by economies of scale have produced some results in terms of specialization agreements in various industries. However, "so far only the first steps have been made in this complex and important field and the advantages of socialist division of labor have not yet been fully utilized" (Vajda, 1971, p. 54). While specialization agreements have assumed importance with regard to products such as machine tools, ball bearings and trucks, their growth has been limited by much the same factors as have restricted the expansion of intra-CMEA trade in general. The lack of direct contact among firms in CMEA countries reduces information flows, and tends to exclude some promising forms of cooperation. Thus, there are few agreements on the division of the production process through the exchange of parts, components, and accessories, or through common ventures by industrial firms. The realization of the CMEA objectives is hindered by the non-availability of goods according to appropriate specifications and at the desired time. Also, in the absence of scarcity prices, it is difficult to evaluate the gains from specialization.

E. The Measurement of Integration

Most of the techniques proposed to measure the progress of integration dealt chiefly with trade. Thus most empirical assessments of the net benefits of the participant countries have been confined to the trade creation effects and have relied on the traditional Vinerian model which gave rise to these concepts in the first place. Each such attempt at quantification is thus based on measurement of the areas pointed out in figure (1) br (indicating trade creation)

relative to tT (representing trade diversion). The first step is to use a fully specified structural model of domestic and international trade. Such calculations may be made ex ante, the appropriate position for decision making, or ex post.

Ex ante estimates are those that rely solely on the sort of a priori knowledge that a planner might command before integration commenced. The accuracy of ex ante forecasts of trade effects depend on the reliability of the price elasticities that are used. In addition to this general problem, a key issue is whether the effect of a tariff is the same as that of an equivalent price change. The thorough investigations by Kreinin (1961) and Krause (1962) have established the fact that tariff elasticities substantially exceed the usual import-demand elasticities.

Ex post estimates are based on some form of analysis of the historical experience of integration. The effect of integration is computed by comparing actual trade to a model that is constructed by projecting trade flows on the assumption that no integration would take place. All studies use the familiar assumption that market shares tend to be rather stable in the absence of integration. This assumption makes this approach inapplicable to LDC's. They also use the common sense idea that the validity of this assumption can be increased by disaggregating markets by products. Perhaps the chief goal of studies of integration is to discover whether there has been trade creation. This can be verified only by observing trade matrices that cover both domestic and foreign sales (Harik, 1978, p. 16). Balassa's method is much simpler and more operational for estimating trade

creation, trade diversion, and welfare (consumption) gains. His method consisted of two simple steps:

(1) to compute income elasticities of demand for ultra-union and extra-union and total imports between the preunion and postunion periods; and

(2) to convert the increase in the income elasticity of demand for total imports (thereby representing net trade creation) into national income terms by multiplying by the assumed efficiency gain implied by a one percent increase in imports relative to national income.

Balassa's approach would seem valid and unbiased only as a measure of what it was specifically designed to measure: trade creation in the fairly narrow Vinerian sense. It would seem, however, to represent neither a satisfactory method of measuring total trade creation (including the growth-induced effects on imports) nor a method of capturing the total effects of customs union participation, as some practitioners would like it to be (Nugent, 1974, p. 35). Nugent says

> since any new industry that became located within the region after the formation of a customs union would be identified as an example of trade diversion, both the Balassa and Viner methods would have the effect of underestimating net trade creation in the broader sense.

Each of the above approaches to assessment of CU's has been limited to their impact on trade directly. As has already been mentioned, the effects of CU's on efficiency, income, growth, etc., which affect trade only more indirectly have been treated less frequently. On most of these effects, progress in measuring has been very limited.

F. Concluding Remarks

Most of the theoretical work regarding economic integration has dealt with integration among developed countries in Western and Eastern Europe. The main concern was over the welfare effects of integration as discussed by Viner in terms of trade creation and trade diversion. In order to discuss integration as it relates to developing countries one has to focus on different issues. LDC's objectives in economic integration are to accelerate industrial development and to foster economic growth. Therefore, one has to discuss the effects of integration on factors of production in terms of availability and mobility. One problem that is associated with integration is the concentration of factors of production in high-growth areas which might lead to increasing economic disparity among regions. Some positive effects of integration had to do with improving specialization, thus avoiding the inefficiency that might be caused by duplication. Specialization could be either inter- or intra-industry. The economies of scale argument has also been advanced as an argument for integration among LDC's. The argument is that in order to construct "efficient" size plants one has to have an extensive market that would not be optimal for any single country and the alternative is to join the various small markets into one large market that will justify the construction of large-size plants.

Chapter 2

Theoretical Framework

A. Introduction

Factor integration implies the removal of discrimination between the economic agents of Libya and Egypt. This assumption is to ensure the free mobility of resources between the two economies. Furthermore, factor integration requires the formation and application of coordinated and common policies within and between states on a sufficient scale to ensure that the major economic and welfare objectives are fulfilled, including in particular the allocation of resources in the most efficient way. The optimization of resources will require at one point in this study invoking the assumption of a competitive factor market. Although this assumption may not be realistic, the major results of this study hold as they are not necessarily based on that assumption.

The assumption of similar technology in both economies is crucial in evaluating the way in which resources should be allocated between the two economies. Although this may be hard to accept, at least the results do not challenge the assumption. Because of the relatively small size of both economies, the effect of their union on the price level will be negligible. Henceforth we assume that prices will remain constant at least through the initial phases of the economic integration. Finally, throughout this study the social and political constraints are assumed to be

neutral. Next we will consider the main analytical tools that will be used in this study.

B. Limitations on the Study

The results of the empirical study should be taken with caution due to several limitations. First and foremost is the lack of requisite data and the imperfect character of such statistics as are available. In most cases, aggregate figures are available through two major sources: 1) international institutions such as the United Nations, the World Bank and the various OPEC institutions; and 2) government sources. Although the aggregate figures differ, and sometimes markedly, they are generally consistent and are probably the most reliable. The approach to these figures was one of comparison, where each set of data is adjusted based on the estimates from the three primary sources. The major limitation is the lack of more detailed data. They are very hard to come by and what is available is very rarely up to date. The data on wages and unemployment fall into this category.

The second limitation is the aggregative nature of the study. Like any macro study, the present model reduces relationships that are vastly complex in real life into compact, high aggregative economic relationships. It is impossible, therefore, to assemble at one central point all the detailed information about two vast economies. Although desirable at certain stages of the analysis, such information is not deemed necessary for the major objective of the model. It was felt that a macro model was best suited to analyze

the main effects of allocating labor and capital between Egypt and Libya. First to analyze the relationship between those two inputs such as their productivities, their rates of substitution, etc., within each economy separately, and secondly, within the integrated economy. Once such basic interconnections are discovered they can provide the starting point from which further and more detailed analysis can be carried out.

The data limitations mean that the major thesis of this study can be only partly supported by empirical results. They rest, of course, on a sound analytical base of the effects of a union between two highly complementary economies. One must include here the effects of significant variables which defy measures and which will be highly favorable, once the political constraint, treated as exogenous, is rendered obsolete with the formation of the union. On the whole, however, the data do not contradict the major theses of this study, the exceptions being minor and not damaging to the arguments put forward.

C. Productivity and the Production Function

Productivity is generally used to denote a relationship between output and the associated inputs used in the production process. In this chapter, we are concerned with the marginal and average productivity concepts used in static equilibrium theory. We are also concerned with the relationship between outputs and inputs, in real terms, over time in a dynamic economy. The basic objectives of productivity estimates are:

1) Obtaining estimates of input productivity. This helps in assessing the performance of Egyptian labor and capital.

2) Obtaining at least rough measures of the impact on production of more investment, improved technology, and similar productivity enhancing variables.

We now consider the notion of production function, which is the organizing principal behind measurement of the productivity relationship. The general form of the production function may be expressed as follows:

$$Q = f(X_1, X_2, \ldots . X_n)\ (T) \qquad 2.1$$

Q designates the potential or actual physical volume of output. Output may be defined in various ways; the important thing is that, given the output definition, the associated inputs (X) on the right-hand side be defined and measured consistently. In this study we generally take inputs to represent the real potential or actual services of the basic factors of production. Measures of factor service input are consistent with measures of net output, or "value added."

The factor inputs may be defined broadly or narrowly. Broadly, they may include the services of tangible as well as intangible resources, i.e. the stock of productive knowledge incorporated in the labor force and in nonhuman instruments of production, or "disembodied" as in the organization of production. Or they may be taken to include only the tangible factor inputs unadjusted for changes in knowledge and other factors affecting efficiency. It is the latter approach which is used in this study. The tangible inputs themselves may be measured in terms of various types of labor and

nonhuman capital services, or they may be collapsed into the two broad factor classes of labor (L) and capital (K). Since we will use a two-factor approach, the production function can be narrowed to:

$$Q = f(L,K)\ (T) \qquad 2.2$$

The variable, T, sometimes loosely called "technology," really combines all other factors which affect output apart from the physical volume of the tangible factor inputs. It is less misleading to refer to T as the "productive efficiency" of the tangible factors. Since the intangible capital stock accumulated through investments in research and development, engineering, education and training, and so on, is the chief element behind such productive efficiency, one would expect T to show much less change if such intangible inputs were incorporated in the tangible inputs.

Cobb-Douglas production function can be expressed as follows:

$$Q_t = A_t L_t^{\alpha} K_t^{\beta} \qquad 2.3$$

α and β are the elasticities of output with respect to labor and capital, and A_t is the level of productive efficiency in year t. The CD function becomes linear in the logarithms, hence

$$\log Q_t = \log A_t + \alpha \log L_t + \beta \log K_t \qquad 2.4$$

The marginal productivity of the factors of production indicate the returns that might be expected, on the average, from the addition of various resources. The marginal physical product of a given input, then, is the partial derivative of the output with respect to that input, all other inputs held constant.

$$\varepsilon Q_t L_t = \frac{\partial Q_t}{\partial L_t} \cdot \frac{L_t}{Q_t} = (\alpha \frac{Q_t}{L_t}) \cdot \frac{L_t}{Q_t} = \alpha \qquad 2.5$$

Therefore in the Cobb-Douglas function, the elasticities of production are given directly by the respective input exponents and they are constant over the entire input-output curve.

Under the conditions of perfect markets, the optimum allocation of resources is achieved when the marginal productivity of each factor is equal to its opportunity cost (Nicholson, 1972, p. 337).

$$\frac{\partial Q_t}{\partial L_t} = \alpha \frac{Q_t}{L_t} = \frac{W_t}{p} \qquad 2.6$$

where W_t is the money wage factor of i, and p is the price of the product.

Then, in order to detect the degree of efficiency in the allocation of resources, we can directly compare the marginal productivity of a factor to its opportunity cost. If the ratio of marginal productivity of a factor to its opportunity cost is less than one, too much of the given resource is being used. If the ratio of marginal productivity to opportunity cost is more than one, too little of the given factor is being used. Maximum efficiency occurs when marginal productivity of a factor is equal to its productivity cost.

D. Translog Production Function

The transcendental logarithmic function which was suggested by Christensen, Jorgenson and Lau (1970) represents a useful generalization by comparison with Cobb-Douglas and the ordinary constant elasticity of substitution (CES) production function in that one may analyze and estimate under fairly general conditions the partial

elasticities of substitution among all pairs of the n>2 inputs.

The CD form restricts all such elasticities to unity and the multifactor CES form is undesirably restrictive either because of the need to specify a priori certain input separability conditions or because of the a priori requirement that substitution elasticities stand in fixed ratios to one another.

A translog production function describing the relation between physical output and input services from two productive factors may be written

$$\ln Q = q(\ln X_1, \ln X_2) \qquad 2.7$$

where

X_1 = physical capital

X_2 = labor

The specific form of translog

$$\ln Q_t = \ln a_0 + \sum_{i=1}^{2} a_i \ln X_i + \sum_{i=1}^{2}\sum_{j=1}^{2} \ln X_i \ln X_j \qquad 2.8$$

$$\ln Q_t = \ln a_0 + a_1 \ln X_1 + a_2 \ln X_2 + 1/2\,(b_{11}\ln X_1 \ln X_1 + b_{12}\ln X_1 \ln X_2 \ldots + b_{21}\ln X_2 \ln X_1 + b_{22}\ln X_2 \ln X_2) \qquad 2.9$$

a_0 = the constant term representing the state of technological knowledge

$a_i b_{ij}$ = the coefficients representing the technologically determined production parameter

Assumption for Equation 2.8.

1. If one disregards the log-quadratic terms, 2.8 is simply a one-input Cobb-Douglas function in which a_i is strictly positive

output elasticity of the ith input. Yet if one or more b_{ij} is non-zero, 2.8 is distinctly different from the Cobb-Douglas form.

2. Note also that all input levels must be strictly positive, since if $\ln X_i$ or $\ln X_j$ ---> ∞, output becomes ill defined.

3. The production function 2.9 is linear homogeneous or subject to constant returns to scale. The following parameter restrictions pertain:

$$\text{i)} \sum_i a_i = 1$$

$$\text{ii)} \sum_i b_{ij} = 0$$

$$\text{iii)} \sum_j b_{ij} = 0$$

$$\text{iv)} \sum_i \sum_j b_{ij} = 0 \qquad 2.10$$

4. The symmetry restriction

$$b_{ij} = b_{ji} \qquad i, j = 1,\ldots\ldots,n$$

5. Output elasticities must be positive. These elasticities are in general not constant but depend on the levels of input services. Thus the output elasticity for i, Σ_i, can be derived from the partial logarithmic derivative as

$$\Sigma_i = (\partial \ln Q_t / \partial \ln X_i) = (\partial Q_t / \partial X_i)(X_i / Q_t) = f_i \cdot (X_i / Q_t) \qquad 2.11$$

and also

$$\Sigma_i = (\partial \ln Q_t / \partial \ln X_i) = a_i + \sum_{j=1}^{2} b_{ij} \ln X_j \qquad 2.12$$

with the assumption that input and product market are competitive (the relaxation of this assumption will be considered later on), the necessary condition for efficient production.

$$f_i = P_i \qquad 2.13$$

where P_i is the price of the ith factor service for each input. The assumption of constant prices facilitates the normalization of the previous condition; i.e.

$$1 \cdot f_i = P_i$$

where 1 is the price of output. Therefore, the marginal product of X_i, f_i, is

$$f_i = (Q_t/X_i)(a_i = \sum_{j=1}^{2} b_{ij} \ln X_j) \qquad 2.14$$

the direct second-order derivative for X_i

$$f_{ii} = (Q_t/X_i^2)[b_{ii} + (a_i + \sum_{i=1}^{2} b_{ij} \ln X_{j-1})$$

$$(a_i + \sum_{j=1}^{2} b_{ij} \ln X_j)] \qquad 2.15$$

the cross partial derivative with respect to X_k is

$$f_{ki}=(Q_t/X_k X_i)[b_{ki} + (a_k + \sum_{i=1}^{k} b_{kj} \ln X_j)$$

$$(a_i + \sum_{j=1}^{k} b_{ij} \ln X_j)] \qquad 2.16$$

where i,j,k, = 1,....,n

From 2.14, it is clear that the translog production function allows the possibility of processing uneconomic regions over certain ranges of input space which causes $f_i<0$. For a given usage of a finite amount of X_i, f_i becomes negative if either

1) X_j ---> 0 and $b_{ij}> 0$

2) as X_j increases indefinitely and $b_{ij}<0$ i,j = 1,....,n

Substituting 2.13 into 2.11 yields the necessary conditions for economic efficiency with reference to the distributive shares:

$$S_i = P_i X_i / Q_t \quad 0 \qquad i = 1,2 \tag{2.17}$$

where, given the assumption of first degree homogeneity in production, Euler's theorem demonstrates that S_i is the relative cost share of the ith input in the total cost of all inputs used to produce Q, i.e.

$$S_i = P_i X_i / P_j X_j \quad \text{for any input } X_i \tag{2.18}$$

or

$$S_i = (P_i X_i / Q_t) = (f_i X_i / Q_t) = \Sigma_i = a_i + \sum_{j=1}^{2} b_{ij} \ln X_j \tag{2.19}$$

By estimating equation 2.19, this will yield the estimated values of the production function parameters in 2.9, which in turn will allow us to compute the values of f_i, f_{ii}, and f_{ki} respectively.

The above translog production function gives us the knowledge to identify the relationship between any two inputs, i and j, whether they are substitutes or complementary. Allen partial elasticity of substitution (AES) σ_{ij}, measures the effect on the quantity of factor i due to a change in the price of factor j holding output and other input prices constant. Then:

* $\sigma_{ij} > 0$ if i and j are substitutes in production
* $\sigma_{ij} < 0$ if i and j are complementary in production

*$P_i X_i / Q_t > 0$ is the condition needed for the function to be well behaved, i.e. globally convex.

$$\sigma_{ij} = \left(\sum_{i=1}^{2} f_i X_i / X_i X_j \right) \left(|\bar{F}_{ij}| \; / \; |\bar{F}| \right) \tag{2.20}$$

where

$|\bar{F}|$ = is the determinant of the bordered hessian matrix

$$\begin{vmatrix} 0 & f_i & f_2 \\ f_1 & f_{11} & f_{12} \\ f_2 & f_{21} & f_{22} \end{vmatrix}$$

and $|\bar{F}_{ij}|$ is the cofactor of the i,j element, f_{ij}, of $|\bar{F}|$.

E. The Regression Model

We estimate the parameters of 2.9 using stochastic versions of equations 2.19. Substituting the distributive share of each input for its output elasticity, the system of cost share equations for this translog production function can be written as follows:

$$S_1 = a_1 + b_{11}\ln X_1 + b_{12}X_2 \qquad 2.21$$

$$S_2 = a_2 = b_{12}\ln X_1 = b_{22}X_2 \qquad 2.22$$

The equality of relative shares and corresponding output elasticities is established by profit-maximizing behavior in competitive markets. But introducing the disturbance terms into the stochastic versions of 2.21, 2.22 will allow the model to deviate from the purely competitive market. This relaxation may be attributed to a variety of forces, including imperfectly competitive markets. This is in effect a more realistic case for the discussion of Libya and Egypt, as we shall see later on.

With the imposition of the linear homogeneity restrictions, the system of n equations of the above type become a singular system (Grant, 1979, p. 8). A non-singular set of share equations can,

however, be constructed by expressing the parameter of the nth equation in terms of the remaining n-1 equations, i.e.

$$S_i = a_i + \sum_j b_{ij} \ln(X_i/X_n) + n_i \qquad 2.23$$

where $n = 1,2, j(i,j \neq n) = 1,2$

Thus, if we choose to estimate equation 2.21, the set of factor share equation would appear as follows:

$$S_1 = a_1 + b_{11} \ln(X_1/X_2) \qquad 2.24$$

From the estimated parameter of the two equations, 2.21 and 2.2, using version 2.24 together with the assumption of linear homogeneity and the symmetry restrictions, we will be able to identify exactly all parameters of the production function 2.9.

The remaining parameters are determined from the linear homogeneous constraints

1) $a_1 + a_2 = 1$
2) $b_{21} = -b_{11}$
3) $b_{12} + b_{22} = 0$

Similar procedures will yield a share equation:

$$S_2 = a_2 + b_{12} \ln(X_1/X_2) \qquad 2.25$$

For each system of the share equations, the disturbances are likely to be correlated across equations. Thus for any i and j, u_i is likely to be correlated with u_j. This suggests that Zellner's (1963) two stage estimation will yield efficient parameter estimates.

However, the estimators obtained by Zef estimation depend on

which equation in the system equation 2.21, 2.22 is chosen. Maximum likelihood estimates would, of course, be independent of which equations were selected. Kementa and Gilbert (1968) demonstrated in a series of Monte Carlo experiments that maximum likelihood (ML) and Iterated Zellner efficient estimation (IZEF) lead to identical estimates in all samples.

From the estimated parameters a_i and b_{ij}, we can calculate the value of the first derivative, f_i, and second derivative, f_{ij}. Equations 2.14, 2.15, and 2.16 indicate that the values of the f_i and f_{ij}, and therefore the numerical values of $|F|$ and $|F_{ij}|$, generally vary with the levels of input usage. Therefore, we will present point estimates of the partial elasticities evaluated at the sample means.

Using equation 2.19, the mean value of the relative cost shares of each input will be

$$\overset{*}{S}_1 = a_i + \sum_{i=1}^{2} b_{ij} \ln \overset{*}{X}_j \qquad \text{for } j = 1,2$$

where the starred variables refer to sample means. Then the first and second derivatives with respect to the other inputs evaluated at sample means will be

$$\overset{*}{f}_1 = (\overset{*}{Q}_t/\overset{*}{X}_1)\cdot\overset{*}{S}_1$$

$$\overset{*}{f}_1 = (\overset{*}{Q}/\overset{*}{X}_1)\cdot\overset{*}{S}_1$$

$$f_2 = (\overset{*}{Q}/\overset{*}{X}_2)\cdot S_2$$

$$\overset{*}{f}_{11} = (\overset{*}{Q}/\overset{*}{X}_1^{\,2})(b_{11} + \overset{*}{S}_1^{\,2} - \overset{*}{S}_1)$$

$$\overset{*}{f}_{12} = (\overset{*}{Q}/\overset{*}{X}_1\overset{*}{X}_2)\ (b_{12} + \overset{*}{S}_1\overset{*}{S}_2)$$

$$f_{22} = (\overset{*}{Q}/\overset{*}{X}_2^2)\ (b_{22} + \overset{*}{S}_2^2 - \overset{*}{S}_2)$$

The determinant of the bordered Hessian matrix will be

$$|\overset{*}{F}| = \begin{vmatrix} 0 & f_1 & f_2 \\ f_2 & f_{11} & f_{12} \\ f_2 & f_{21} & f_{22} \end{vmatrix}$$

$\overset{*}{F}_{ij}$ is the cofactor of the i, jth element of $|\overset{*}{F}|$

i.e. $|\overset{*}{F}_{ij}| = (-1)^{(i+j)}\ |M_{ij}|$

where $|M_{ij}|$ is the minor of the element $\overset{*}{f}_{ij}$ (the element at the intersection of the deleted row and column) and is obtained by deleting the ith row and jth column of the determinant of the bordered Hessian matrix $|\overset{*}{F}|$. For example,

$$|\overset{*}{F}_{12}| = (-1)^{(1+2)} = \begin{vmatrix} 0 & f_1 \\ f_2 & f_{21} \end{vmatrix}$$

The Allen partial elasticity of substitution (AES) between capital and labor will be

$$\overset{*}{\sigma}_{ij} = (\sum_i \overset{*}{f}_i \overset{*}{X}_i / \overset{*}{X}_1 \overset{*}{X}_2)\ (|\overset{*}{F}_{12}| / |\overset{*}{F}|)$$

1. The monotonicity and concavity conditions

A production function is well behaved if, and only if, the marginal product of each input is positive, and if it is globally convex. In general, the unrestricted translog production does not satisfy these conditions. This condition can be checked in this

study as follows:

a. The monotonicity conditions require that the marginal product of each input is positive

$$S_i > 0$$

b. The concavity condition requires that the Hessian matrix of partial second derivations be negative semi-definite or ($|H| < 0$). We can check this condition using

$$|\bar{H}| = \begin{vmatrix} f_{11} & f_{12} \\ f_{21} & f_{22} \end{vmatrix}$$

2. Model estimation

First, the disturbances in each system of the share equation are likely to be correlated across equations within the system. For this reason IZEF estimation method will be employed as indicated by the earlier discussion.

Second, one of the constraints of the translog production function is the symmetry restriction. In general, one cannot estimate a set of unique parameters under the symmetry constraint because for any equation of the system, the estimates b_{ij} and $b_{ij}(i \neq j)$ will not generally be equal when least squares is applied to each equation individually. Fortunately, the IZEF estimation method is capable of handling this symmetry restriction. Hence, the symmetry restriction will be taken into account in the estimation method.

The estimation procedure will proceed in two different stages.

The first stage

The purpose of this stage of the estimation procedure is to find the starting points for the parameters which will be estimated using IZEF estimation in the second stage. The estimation in the first stage is obtained by stacking the two equations into a single matrix equation in order to enforce the symmetry constraint. Each equation will be estimated by OLSQ.

The second stage

The purpose of the second stage is to estimate the system of the share equation by IZEF estimation. The numerical values, which are obtained from the estimation in the first stage, will be provided as the starting points for respective parameters at this stage from the estimates obtained by IZEF estimation, together with the assumption of linear homogeneity and the symmetry restrictions. We will be able to identify uniquely all the remaining parameters of the production function.

F. Data Considerations

In light of the fact that there are no systematic and reliable data on the stock of capital in Libya, the decision was made to utilize lagged cumulative investment as a proxy for capital. This procedure is adopted in several other models, and has merits in economic theory. Thus capital input will be measured as gross fixed capital formation (GFCF) adjusted for inventory and depreciation. The data for the lagged cumulative investment are available in the United Nations' Yearly Book of Statistics, and National Income

Accounts for Libya and Egypt. The data for inventory and depreciation are available also in the quarterly bulletin of the central banks. The year 1970 was used as a base year to generate the series of the real capital stocks for the period 1960-1979.

Employment data for Libya are taken from the Population Census 1954, 1964, and 1973. The source for the distribution of labor force was International Labor Organization 1962-1978. Data on labor force and employment for Egypt are taken from the Population Census and Labour Force Survey 1976. The major deficiency regarding labor as an input is that it is taken as a homogeneous factor. An attempt was made to account for human capital by distinguishing between skilled and unskilled labor. The classification was made based on the distribution of labor force by occupation. However, the estimates thus obtained were unsatisfactory. The data on the distribution of the labor force by years of education and the corresponding earnings, which obviously would make a better estimate of human capital, were not available.

The data for the distributive shares between labor and capital are constructed as follows. Assuming that the distributive shares of of inputs exhaust total cost (Christensen and Jorgensen, 1969, p. 24), the total costs of production at period t are apportioned between the wage bill in the same period and total capital costs from the previous period. Total cost is computed by total labor costs (the wage bill) plus total capital costs. The distributive shares are calculated by dividing the cost attributable to each input by total cost (Humphrey and Moroney, 1975, p. 66). Hence

$$(\text{Total cost})_t = (\text{labor cost})_t + (\text{capital cost})_{t-1}$$

$$= (\text{compensation cost})_t + (\text{income from property})_{t-1}$$

and

S_L = labor share = $(\text{labor costs})_t/(\text{total cost})_t$

S_k = capital share = $(\text{capital costs})_{t-1}/(\text{total cost})_t$

The labor cost or the wage bill for each economy is determined from the labor compensation from the national income accounts. The data for the "compensation of employees" is available in the National Income Account of Egypt and the National Accounts of Libya. The capital cost for each economy is measured using property income which is also available from the national income account for each country.

Chapter 3

Capital Surplus in Libya

A. Introduction

Libya combines within the borders of one country virtually all the obstacles that can be found anywhere: geographic, economic, political, sociological and technological. It was thought that if Libya could be brought to a stage of sustained growth, there would be hope for every country in the world (Higgins, 1968, p. 26). This is a good description for the state of the Libyan economy in the late 1940's and throughout the 1950's. When the country took its independence in 1951, the economy was in a shambles. Indeed, the prevalent view was that real development was not possible. The country seemed to lack all major prerequisites for development.

Libya had little known natural resources that could be developed. In fact, there were years (during and after World War II) when the rate of capital formation was negative. A great deal of the country's overhead capital, such as harbors, buildings, roads and water wells, was either destroyed by war or used up by total or partial depletion. Bejamin Higgins (1968, p. 26) described the situation as follows:

> Libya's great merit as a case study is as a prototype of a poor country. We need not contruct abstract models of an economy where the bulk of the people live on a subsistence level, where per capita income is well below $50 per year, where there are no sources of power and no mineral resources, where agricultural expansion is severely limited by climatic condition, where capital formation is zero or less, where there is no skilled labour supply and no indigenous entrepreneurship. When Libya become an independent kingdom under United Nations

> auspices (Dec. 1951) it fulfilled all these conditions. Libya is at the bottom of the range in income and resources and so provides a reference point for comparison with all other countries.

Since the above was written, there has been one dramatic change: the discovery of oil and along with it the growth of oil revenues. Other constraints remain, however, indicating a limit to domestic absorptive capacity.

In this chapter, we will examine closely the continuing importance of the obstacles facing the economy and the limits to domestic absorptive capacity in view of increasing oil revenues since the mid-1960's.

B. Capital Surplus

The availability of capital in large amounts in Libya is generated mainly by the production of oil. The Libyan economy has been a net "lender" to the rest of the world since 1963 (the year in which oil was produced at a commercial level). Lending capital, which is a national surplus, has increased from about $824 million to $3,111 million in 1977 (Table 3-1). However, if the oil sector is excluded Libya becomes a net "borrower" from the rest of the world, as shown in Table 3-2.

Two points should be noted here. First, the yearly surplus of the total economy is increasing, suggesting that the rate of increase in oil revenue exceeds the rate of increase in expenditure. Second, the non-oil sector deficit is also increasingly subsidized by the oil sector, which is equivalent to saying that the economy is becoming increasingly reliant on the oil sector in closing its

TABLE 3-1.

NET EXTERNAL TRANSACTIONS: TOTAL ECONOMY

	1971	1972	1973	1974	1975	1976	1977	1978
Surplus on goods, services and income payments	2883.9	3162.3	4264.2	8704.4	7153.7	9918.3	11835.2	10395.6
Current transfer--capital transfer	2059.7	2766.3	4296.3	6775.0	7469.9	7722.6	8723.6	9368.3
Net lending by the nation to abroad	+324.1	+396.1	-32.1	+1929.4	316.2	2195.6	+3111.4	+1207.4

Souce: Computed from Libyan Arab Republic Ministry of Planning National Accounts, 1970-1978.

TABLE 3-2.

NET EXTERNAL TRANSACTIONS: NON-OIL SECTORS

	1971	1972	1973	1974	1975	1976	1977
Surplus on goods, services and income payments	-1176.6	-1528.3	-2501.0	-4481.0	-5195.2	-5071.6	-5768.9
Current transfers	- 100.28	-1237.0	- 351.8	- 73.6	- 166.5	- 143.9	- 150.3
Capital transfers	0.0	0.0	0.0	0.0	-3.3	-13.5	-10.5
Net lending by oil sectors to abroad	-1276.8	-2765.3	-2852.8	-4554.6	-5365.0	-5229.0	-5929.7

Source: Computed from Libyan Arab Republic Ministry of Planning National Accounts, 1970-1978.

trade gap. Higgins uses this fact to describe the deficitory nature of the Libyan economy, arguing that it calls for restructuring the economy (Higgins, 1968, p. 823). However, the exclusion of the oil sector from all other sectors to highlight the "deficitory nature" of the Libyan economy does not appear legitimate. The undisputed fact is that oil has been the pacesetter of all other sectors where development in these sectors has been intiiated and sustained only by the surplus in the oil sector. This is to say that if the oil sector did not exist, the deficit in other sectors would not grow at the same rate as it did. Thus, to exclude oil without, at the same time, excluding its effects is a biased procedure that would give unwarranted conclusions. The fact is that as the surplus of the oil sector grows, the rate of its utilization for the benefit of the other sectors grows also, but less than proportionately. Since the bulk of expenditures had to go to many basic areas of investment, such as health, education, power, transport, communication, and so forth, little has been shown in the form of a flow of goods and services that could offset the deficit. On the contrary, increased expenditure in these areas has stimulated consumption, thereby aggravating the deficit (El-Jehaimi, p. 97).

The surplus in the oil sector is the source of almost all the foreign exchange Libya earns. The fact that the surplus has been increasing at a faster rate than imports and transfer payments for all years resulted in a rapidly increasing pool of international reserves. This can be seen in Table 3-3.

TABLE 3-3.

INTERNATIONAL RESERVES (IN MILLIONS OF DOLLARS)

	1969	1970	1971	1972	1973	1974	1975	1976	1977
Foreign exchange	828	1.499	2.566	2.826	2.017	3.504	2.088	3.099	4.779
Reserve position in IMF	5	6	7	7	7	7	7	7	7
gold	85	85	93	93	103	104	100	99	104
International reserve	918	1590	2665	2925	2127	3616	2195	3206	4891
Imports	676	674	765	1189	1687	3115	3644	3705	4466
Reserve imports ratio	1.35	2.36	3.53	2.46	1.26	1.16	.60	.86	1.09

Source: Reserves statistics are from IMF, International Financial Statistics, (Washington, D.C., years 1975,.....,1979).

C. Absorptive Capacity

1. Definition of absorptive capacity

Branco Horvat was perhaps the first economist to formulate a formal definition of absorptive capacity. His definition was a byproduct of his attempt to determine the "optimum rate of investment." Horvat hypothesized that the maximization of production through time was the objective of the economic process and added that

> Maximization involves not only the allocation of factors of production now, but also the adjustment of their various rates of expansion in the future. The potential effect of the optimum adjustment of the growth rates of factors is defined as the absorptive capacity of the economy (Horvat, 1958, p. 748).

Horvat adds a statement of clarification by pointing out that the "easiest way to use this concept is to conceive of the economy as a giant productive capacity capable of being expanded at a certain maximum rate. Any additional inputs (investment) would not produce additions to but reductions of output" (Horvat, 1958, p. 751).

The formulation of the new concept of absorptive capacity and the examination of its implication for policy matters have been closely associated with Benjamin Higgins, Rosenstein-Rodan and Raymond Mikesell.

In his textbook, Higgins defines the concept as

> ...the amount of investment that can be undertaken within a five-year program, without reducing the marginal contribution of the last "block" of capital below 'X'. In other words, it is the amount that can be undertaken without raising the incremental capital output ratio of the last block of investment, or marginal ICOR, above 1/X (Higgins, 1968, p. 579).

Higgins makes a connection between 'X', the rate of return on

investment, and the cost of capital. Thus if the cost is zero, capital investment should be pushed to the point where its marginal efficiency becomes zero. If, on the other hand, capital is to borrowed at a rate of 'Y' percent, then 'X' should not be set lower than 'Y'. Generally, 'X' should be set at the margin, equivalent to the rate obtainable at the best alternative use of the invested capital.

Raymond Mikesell suggested a concise definition borrowed from capital theory. He stated that absorptive capacity was

> ...the ability of a nation or economic community to transform financial capital into an equivalent amount of real productive capital (as measured by the discounted value of the net outputs) (Mikesell, 1966, p. 360.

Like Higgins, Mikesell's definition establishes a link between investment productivity and its cost. According to Mikesell, financial capital should continue to be invested or transformed into tangible productive capital until the present value of future additions to output is just equal to the supply price of presently invested capital. Mikesell's definition is particularly important for the oil-exporting countries such as Libya, where the choice is roughly between oil underground, financial investment abroad, or domestic development. The definition suggests that oil production should be continuously adjusted to the yields from the latter.

Development economists have been focusing on increasing investment and productive capacity bypassing issues raised by considerations of absorptive capacity. They have often assumed that productive investment is whatever a nation can undertake over a given period of time. Absorbable capacity was also simply assumed to be

whatever foreign aid a developing nation could effectively integrate into its development plans and expenditures. But there has been a renewed interest in the constraints that limit investment productivity and in the notion of absorptive capacity as a reference to decreasing returns. The hypothesis of diminishing returns states that any successive additions of a variable factor applied to fixed rates of other factors in the process of production will eventually yield diminishing marginal contribution to total output. It is assumed that technology remains the same throughout the process. The rationale of the law lies in the fact that in the absence or shortage of other factors, the variable factor will be at a growing disadvantage in adding to the output.

D. Limited Absorptive Capacity

The accumulation of foreign reserves at a rate faster than the growth of imports can be viewed as a strong indication of a limited absorptive capacity (El-Jehaimi, p. 113). Moreover, this capacity is even more limited in view of the acceleration of oil prices in recent years. Unlike several other major oil-producing countries in Africa and the Middle East, such as Algeria, Nigeria, Iran and Iraq, Libya has a very small population, much less diversified economy, and meager natural resources other than oil. Yet Libya earns in revenue at least as much as any of these countries. Table 3-4 shows how Libya compares with these countries in terms of some relevant indicators.

TABLE 3-4.

POPULATION, GDP SHARES, AND OIL EXPORTS OF LIBYA AND OTHER PRODUCING COUNTRIES

	Population (millions)	Per Capita GDP (U.S. $)	Share of Agriculture (percent)	Share of Industry (percent)	Oil Exports (U.S. $, millions)
Libya	2.10	1750	3	2	2378
Iraq	9.44	385	17	9	1029
Iran	26.66	407	18	NA	2358
Algeria	14.33	324	NA	NA	667
Nigeria	55.07	140	44	7	713

Source: Yearly Book of Statistics, U.S. 1973, Vol. II, New York, 1975.

In addition, the facts that Libya was in a backward economic state only a decade ago and that oil riches have descended on her so suddenly that only so much can be accomplished in the short run, imply that only a portion of the revenue can be efficiently invested domestically. The remainder will accumulate in the form of foreign reserves, as has already happened.

1. Limitation on domestic absorptive capacity

Before the discovery of oil, Libya was the prototype of a poor and small country with little known natural or human capital. As such, the country provided little opportunity for profitable investment. A World Bank study recommended a public expenditure of only $70 million to be expended in the five-year period that started in fiscal year 1960 (I.B.R.D., pp. 66-74). In 1961, P.N. Rosenstein-Rodan estimated that between 1961 and 1976, Libya could absorb no more than $157 million in investment (Rosenstein-Rodan, pp. 107-138).

The discovery of oil was not automatically a panacea for the social and economic problems of the country. In fact, it could be argued that the oil riches might have reduced overall efficiency in Libya through general distortion of effort-reward relationships in income distribution. In 1966, Benjamin Higgins and Jacques Royer projected that Libya had no chance, even under the most optimistic assumptions about productivity, labor participation and so on, for investing profitably anything near to 70 percent of its oil revenue. In 1972, they estimated that total investment outside the oil sector would reach $600 million or, as it turned out, about 22 percent of actual oil revenue in 1972 (Higgins, pp. 832-834).

In 1974, Dr. T.C. Parks did a study on the petroleum industry impact on economic development in Libya. He concluded that domestic absorptive capacity was indeed limited. He argued that two factors prevented capital productivity from reaching zero in Libya:

(1) The government, realizing limitation on its ability to expand investment, opted for more-than-planned foreign exchange reserves, and less-than-planned investment expenditure.

(2) Meanwhile, the government pursued a policy that allowed foreign skilled and high-level manpower into the country, thereby lessening pressures in the labor market (T.C. Parks, pp. 231-240).

From the fact that the oil revenue increased in recent years at an astronomical rate due to the oil price increase, one is tempted to conclude that domestic absorptive capacity is now even smaller in

relation to this revenue. Turning to more specific evidence other than the general evidence that is already deduced from generalized conditions of the Libya economy, we find two major criteria:

First: Low investment ratio. The Law No. 5 of 1963 states in Article II that at least 70 percent of oil revenues must be spent on development programs. The government failure to comply with the law can be taken as an indication of limited absorptive capacity. During the sixteen year period 1962 - 1978, oil revenue grew at an annual rate of 40 percent, from $39 million to $9389 million. Meanwhile, actual development expenditure grew at only about 27 percent, from $57 million in 1962 to $5175 million in 1978. Total development expenditure in the period has averaged 31 percent of total oil revenues or less than 50 percent of what was required by law. Table 3-5 contrasts revenue with expenditure.

TABLE 3-5.

OIL REVENUE AND ACTUAL DEVELOPMENT EXPENDITURE (1971-1978)
(in millions of $)

Year	Oil Revenue Y	Expenditure on Development X	Ratio X/Y
1971	2597	785.6	30%
1972	2799	1327.4	47%
1973	3782	2127.3	56%
1974	8074	3307.7	40%
1975	6625	3560.3	53%
1976	9290	4138.5	44%
1977	11064	4621.6	41%
1978	9389	5175.6	55%
Annual rate of growth	40%	28%	

Souce: Libyan Arab Republic, Ministry of Planning, 1970-1978

Second: High incremental capital-output ratio. Another point used as an indication of limited absorptive capacity is the high global and sectoral incremental capital output ratio (ICOR's). Between 1971 and 1978, the annual rate of growth in the GDP of Libya was 16 percent with a gross investment at about 23 percent of GNP. The gross incremental capital output ratio (ICOR) will be 1.43 (23/16) (El-Jehaimi, p. 119). It should be pointed out that such a relatively low ICOR does not mean that capital productivity is high. Rather, it is a reflection of the lopsided nature of the Libyan economy. Specifically, the relatively low global ICOR is the result of the fact that petroleum and construction have very low ICOR's.

The two sectors combined make up about 60 percent of the country's entire GDP. Both of these factors are exogenous in the sense that they utilize foreign capital and expatriate labor, and therefore are not subject to the limitations of the domestic economy.

By contrast, the agriculture sector, which is more endogenous than all other sectors, displays an ICOR of about 20. Taking ICOR as a proxy for capital productivity, it could be concluded that the Libyan economy as a whole, oil excluded, has been rather unresponsive to capital application over the last two decades. ICOR's for major sectors are shown in Table 3-6.

TABLE 3-6.

ESTIMATED INCREMENTAL CAPITAL OUTPUT RATIO FOR SIX SECTORS FROM 1971 - 1978

Sector	ICOR
Petroleum	1.3
Construction	2.5
Transportation & Communication	7
Electricity, Gas & Water	37.5
Agriculture	20
Manufacturing	6

Source: Computed from national account data provided by Ministry of Planning, and Yearbook of Statistics, 1979.

E. Labor Shortages

Economic theory has habitually treated labor as a homogeneous factor. In most production functions, "labor" is a total of "average" units or man-hours that must be combined with other factors to produce a certain level of output. However, in order to identify labor elements restraining capacity, and assess the national requirements of different labor categories, labor should be examined as heterogeneous variables.

Labor, as a factor of production, has two restraining effects on absorptive capacity. The first is quantitative in that it shows in general manpower shortages, such as the case in Libya and the Arabian Gulf states. The second is qualitative, in that skills of most varieties are scarce and inefficiency is a widespread phenomenon. This type of restraining effect affects practically all developing countries.

Despite the vast land area, the Libyan population numbered only 2,643,000 in 1977, which gives the Libyan economy one of the lowest population density ratios in the world (3.52 persons per square mile; see Table 3-7).

Taking the supply of labor as positively related to the population size, composition, and rate of growth, it can be seen clearly from Table 3-8 that the labor force in Libya is very small, especially if compared to the resources available. With the proportion of children (under 14 years) in the total population estimated at 48.8 percent (for Libyans it is even higher -- 51.4 percent), the adult population from which the labor force can be drawn is small.

TABLE 3-7.

POPULATION ESTIMATES FOR TOTAL AND LIBYAN NATIONALS FOR THE YEARS 1966-1977

Year	Libyan Nationals	Total
1966	1,621,000	1,696,000
1967	1,677,000	1,766,000
1968	1,734,000	1,838,000
1969	1,794,000	1,914,000
1970	1,855,000	1,993,000
1971	1,919,000	2,075,000
1972	1,984,000	2,160,000
1973	2,052,372	2,249,237
1974	2,123,000	2,342,000
1975	2,195,000	2,438,000
1976	2,071,000	2,539,000
1977	2,384,000	2,643,000

Souce: Census and Statistics Department, Libyan Arab Republic, 1973-1978.

TABLE 3-8.

ESTIMATED TOTAL POPULATION AND LIBYAN NATIONAL AND LABOR FORCE FOR 1965-1977

Year	Male	Female	Total	Labor Force
1965	860,000	763,000	1,623,000	333.1
1966	882,000	808,000	1,690,000	351.3
1967	921,000	839,000	1,760,000	370.2
1968	960,000	872,000	1,832,000	290.4
1969	1,002,000	905,000	1,907,000	410.9
1970	1,046,000	940,000	1,986,000	434.5
1971	1,091,000	977,000	2,068,000	459.0
1972	1,138,000	1,015,000	2,153,000	488.0
1973	1,188,000	1,054,000	2,242,000	538.0
1974	1,239,000	1,095,000	2,334,000	607.0
1975	1,293,000	1,137,000	2,430,000	677.1
1976	1,341,000	1,189,000	2,530,000	710.9
1977	1,370,000	1,264,000	2,634,000	746.4

Source: Census and Statistics Department and Labour Bureau of Statistics Bulletin, 1975.

The size of the work force in Libya is constrained not only by the population size, but also by the following factors: the female/male composition of the population; Libyan/non-Libyan composition; and policies which give rise to structural changes in attitudes toward the role of women in the economy, especially those affecting educational, job, and other societal opportunities available to them. The work force participation rate has been increasing steadily from 32 percent in 1965 to 44 percent in 1977. However, it should be noted that although this is a noticeable increase, it proceeded from a small base. In fact, the current participation rate of 44 percent is small in comparison to all less-developed countries. Second, the male participation rate has increased only slightly as a large number of younger men has postponed joining the work force in order to acquire a higher education level. Thus, the increase is primarily due to the dramatic increase in the female participation ratio, especially in the last seven years.

A feature of the Libyan population, which has implications for labor productivity, is the high illiteracy rate. In 1977, the illiteracy rate stood at 51.6 percent for the population as a whole. Among the female population, the illiteracy rate was a staggering 72.9 percent, while for the male population it was 32 percent.

If we examine the educational levels of the labor force, the effect of illiteracy becomes clear. Table 3-9 shows total manpower in 1977, classified by educational levels.

TABLE 3- 9.

EDUCATIONAL LEVELS OF THE TOTAL LABOR FORCE IN 1977

Educational Levels	No. of workers	%
Below primary and illiterate	593.038	75.0
Primary school certificate	90.240	11.6
Lower-level secondary school	41.196	5.3
Higher-level secondary school	.650	0.1
Teacher's certificate	26.100	3.3
Commerce and accounting certificate	2.810	0.4
Intermediate industrial certificate	1.327	0.2
Agricultural engineering certificate	.984	0.1
Intermediate engineering certificate	.992	0.1
University level and above	23.642	3.0
Total	781.042	100.0

Source: The Ministry of Civil Service, Manpower Survey Report, 1977.

As the table shows, of the total labor force, 75.9 percent has little or no education.

Below, a brief summary of the two main sectors, industry and agriculture, is made in terms of their respective absorptive capacity. The implication of investment performance in these two sectors is analyzed with regard to investment alternatives, particularly the international alternative.

F. Industry

As in many other small underdeveloped countries, industry in Libya was beset by formidable problems. These problems pertain to often-repeated factors: scarcity of skilled and unskilled manpower, lack of indigenous managerial talents, and the backward state of marketing and distribution networks. The only fact that seems

favorable is the country's GNP, which has been rising rapidly, giving the population the purchasing power to place seemingly insatiable demand for many industrial products. However, no matter how great such a demand might be on a per capita basis, the absolute size of the population still may not assure an adequate market to enable many industries to attain the desired minimum economic size. Minimum economic size can be defined in economic terms relative to normal profits and efficient foreign suppliers. It is

> the size at which the domestic firm will be able both to secure normal profits and to compete with existing foreign suppliers, taking into account locational advantages and disadvantages as well as perhaps some infant industry protection (Hirchman, 1958, p. 101).

Almost none of the industries existing in Libya today meet this condition. They are not only heavily subsidized, but are also protected from foreign suppliers by walls of tariffs and quotas.

But even industries that have adequate markets, such as the textile industry, may not be established for a variety of reasons. The absence of aggressive entrepreneurs who are willing to risk their capital and break the crust of tradition is perhaps the most important reason (El-Jehaimi, p. 123). In Libya, the indigenous entrepreneur, which is composed largely of local traders, prefers to put its money into real estate for speculative purposes and into import trade, where the turnover is higher and the risk minimal.

The absorptive capacity of the industrial sector is extremely limited. The first Five-Year Plan (1963-1968) allocated 48 million dollars for industry. This represented only five percent of the 949 million dollar plan budget. But even this small portion was

not all spent. Actual expenditure on industry during the plan period amounted to 41 million dollars, or about 85 percent of initial allocations. The difference between planned expenditure and actual expenditure can be attributed to limitations on absorptive capacity.

During the period 1962 to 1971, industrial value added rose from $28 million to $61 million, or at 8.2 percent per year. However, per capita value added increased by only 4.4 percent per annum. Between 1970 and 1973, over $334 million were actually spent on industrial projects. Most of the investment, however, went to industrial infrastructure and was not immediately transformed into industrial goods. The flow of domestically produced goods continued to represent only a small percentage of imports. In 1972, the entire output of the industrial sector was barely 10 percent of the country's $845 million imports.

In terms of its contribution to the GNP, the industrial sector contributed 5.8 percent in 1962 and only 1.6 percent in 1971; in 1978, its contribution was merely 2 percent.

To get a clearer picture of capital productivity in industry, the value added of the sector (Vi) is contrasted with the gross fixed capital formation of the sector (Ki), as a proxy of capital stock. The figures are shown in Table 3-10. It can be seen that while Ki had increased at about 31 percent per year, Vi had increased by only about 19 percent per year, indicating low effectiveness of capital application in industry.

TABLE 3-10.

VALUE ADDED AND GROSS FIXED CAPITAL FORMATION
1964-1978

	Millions of $		
Year	Value Added (Vi)	Gross Fixed Capital (Ki)	$\frac{Ki}{Vi}$
1964	32.2	9.8	.30
1965	34.5	13.4	.39
1966	38.9	20.7	.53
1967	44.3	23.2	.53
1968	52.9	20.1	.38
1969	54.1	20.1	.37
1970	57.4	19.6	.34
1971	62.3	47.8	.80
1972	90.2	166.8	1.80
1973	133.1	191.3	1.40
1974	189.2	429.0	2.20
1975	221.3	408.7	1.80
1976	306.0	577.7	1.80
1977	421.0	554.0	1.30
1978	502.3	550.6	1.09
Annual Rate of Growth:	19.4	31.1	$\frac{r_k}{r_v} = 1.6$

Source: National Accounts, pp. 28-160.

G. Agriculture

There is no explicit argument against emphasizing the development of agriculture in Libya. On the contrary, there are many who believe that the agriculture sector has been unduly neglected for a long time and that Libya should use part of its oil revenue to revive and modernize its agriculture. Such advocacy, however, is usually qualified by the fact that the agricultural potential is limited for a variety of fundamental reasons: the general aridity of the land, insufficiency of rainfall, scarcity of other water resources, sparseness of the population, and so forth.

Available macro evidence suggests limited absorptive capacity in agriculture. The estimate of the marginal capital-output ratio in the sector was about 11 during the period 1969-1978. By any yardstick, this is a high ratio, implying low capital productivity.

Closer examination suggests that the situation in agriculture may be even worse. Real agricultural output actually declined during the period 1962-1971 in spite of massive subsidies and development by the government as shown in Table 3-11.

In terms of current prices, agricultural output has risen from $41 million in 1962 to $100 million, or at 8.24 percent per year. However, if 1964 is taken as a base period, the value of the output would show less than 1.5 percent per year average increase as shown in Table 3-11. Furthermore, if the amount of subsidies is subtracted, real value added will decline further to below 1962 levels.

Such a precipitous decline is even more serious when considered on a per capita basis. Between 1962 and 1971, agricultural per capita

TABLE 3-11.

VALUE ADDED, GROSS FIXED CAPITAL FORMATION AND SUBSIDIES: THE AGRICULTURE SECTOR 1962-1971

In Million $

Year	Value Added	GFCF	Ratio	Subsidies	Value Added Net of Subsidies
1962	48.49	7.2	.15	.437	48.053
1963	48.27	6.5	.13	.473	47.797
1964	46.02	7.28	.16	.451	45.569
1965	64.43	14.29	.22	.675	63.755
1966	61.31	20.71	.34	.857	60.453
1967	64.68	19.33	.30	1.571	63.109
1968	61.52	22.69	.37	1.796	59.724
1969	63.03	22.69	.36	1.513	61.517
1970	48.31	22.89	.39	6.182	42.128
1971	55.88	43.173	.61	11.199	44.681
Annual Average rate of growth	1.41	16.72		38.32	-0.73

Source: National Accounts, pp. 132-134 and 144-147.

output declined from $33 million to $24 million (constant prices), a drop of more than 30 percent. As a result, Libya had to increase its food imports not only to meet new demands (population increases, income effect, etc.), but also to make up for lost supplies.

H. Implications for Investment: The International Alternative

The conclusion drawn from limited sectoral absorptive capacity is that global or overall absorptive capacity is also limited. That is to say, total (profitable) investment potential will fall short of oil revenues by a considerable margin. Even total national absorption (consumption + investment) is projected to fall short of projected revenues. Once conservation is ruled out as a non-sound alternative, as it is by some economists, another conclusion emerges: foreign exchange will accumulate at a fast rate, calling for a policy of foreign investment. Higgins and Royer (1967, p. 833), for instance, projected that total absorption would be between $1942 million and $2253 million in 1972. Unspent revenues would have to be invested abroad. Wedley projects that total absorption in 1980 will reach $2807 million. The economy will still, however, have some $2364 million in the form of foreign exchange. (In fact, the actual "surplus" was much higher than those projections in 1977; it stood at $4891 million).

Such projections, plus the fact that the country did accumulate vast reserves over the last ten or eleven years, have centered the attention of many observers to the qusetion of international investment as a major investment alternative.

After surveying the agricultural sector, Wedley suggested that funds released from the low-yield investment in agriculture could be invested in liquid foreign assets where "there is evidence that the return will be higher" (Wedley, 1971, p. 320). He did not show evidence, but pointed out that international investment had the advantage of maintaining the national wealth until agricultural development became more feasible.

Similarly, Bryce argued (1968, p. 14) for international investment as a sound and more profitable alternative to industrialization. He stated that "perhaps twenty million pounds invested in Canada or Australia may do more to protect the future of Libya and Libyans than the same amount put into a factory in Benghazi." In fact, a foreign investment portfolio policy in Libya is considered by Bryce as the "best hedge" against the distant day when oil resources are depleted. "Perhaps one of the greatest economic development opportunities for the country (Libya) is to search the world for the best investment opportunities" (Bryce, 1968, p. 13). Bryce does not specify how the "search" can be done or how the foreign investment portfolio can be carried out.

The purpose of foreign investment is to preserve the national capital and make it grow until a time when the economy can more efficiently absorb it. But it would also provide for the consumption needs of the future. By the end of 1974, Libya had accumulated about $3.5 billion in foreign assets. At an interest rate of 8 percent, these assets would more than double in ten years. Allowing a 3 percent rate of growth in population, they will be equivalent to $2,300

on a per capita basis, or about three times the per capita import in 1974. If imports are assumed to grow at 10 percent per year, the same amount of accumulated assets will still be more than enough to finance all imports in 1985. One additional claimed advantage for foreign investment is that it provides against contingencies which could arise out of the uncertainties inherent in a changing political and economic world. Such was the advice Libya received from the World Bank upon consultations regarding the "best way" to handle oil revenues.

The proponents of the idea that Libya should seek international opportunities for its investable funds seem to abstract from extraneous factors which may reduce the economic value of foreign investment. These factors include the possibility of expropriation of some degree of interference by host governments and the hazardous effects of world inflation and devaluations of key currencies. While these factors are of an extraneous nature and are hard to predict, their possible effects must be weighed and discounted by decision makers.

Inflation in the developed countries of western Europe, the United States, Canada, and Japan has averaged higher than ten percent per year over the last seven years. Any investment in these countries should, therefore, realize a rate of return in excess of ten percent in order to just maintain the real value of the principal. Positive real rates of return can be realized only if the nominal rate exceeds the inflation rate plus any expenses that may be incurred in the course of managing the investment. The recent

experience of the oil-exporting countries in this regard appears dismal.

Devaluation is another major problem which has detrimental effects on investing abroad. Libya, as well as other countries holding dollar assets, incurred losses commensurate with the volume of their holdings when the dollar was devalued in 1971 and 1973. The losses of Libya alone are estimated in excess of $100 million. The devaluation of the dollar had another negative effect on Libya. Since oil exports are quoted in terms of the dollar, any depreciation in the dollar would mean, ceteris paribus, that Libya would earn less in terms of the currencies other than the dollar for any given level of oil exports. This means lower purchasing power and smaller investing capacity in non-dollar markets. A country can, of course, protect its foreign investment from devaluation and even inflation by covered arbitrage. But as a form of insurance, covered arbitrage involves high costs, sometimes so high as to result in a negative rate of return.

Conservation as an alternative depends primarily on two factors: the scale and pace of economic development, and the future prices of oil. The expenditure on development programs is limited, as we have shown, by the absorptive capacity of the economy. Thus it is easy to identify the level of oil production needed to meet the requirements of the economy, given of course the prevailing level of prices at a given year. The future direction of oil prices is a difficult variable to predict. However, the experience of the past decade has shown that the demand for oil is quite inelastic,

especially if viewed in terms of the slow development of alternative sources of energy. In view of this, it is safe to assume that the future prices of oil may level off but will not be likely to experience a drastic decline. Therefore, it seems that keeping oil in the ground is not a viable productive alternative.

It is obvious, therefore, that the foreign investment alternative has its own risks and uncertainties which must be evaluated in order to make it comparable to other investment alternatives.

I. Summary

We have seen in this chapter that the Libyan economy has a limited absorptive capacity. Binding constraints (mainly unskilled and skilled labor, entrepreneurship, limitations of nature, etc.) prevent the economy from efficiently absorbing more than 25 to 30 percent of its oil revenues. Conserving oil in the ground is unproductive. International investment is risky and uncertain.

Chapter 4

Labor Surplus in Egypt

A. Introduction

Egypt, like many other developing countries, faces many problems regarding her economic development strategies. While the country's international boundaries draw an expanse of some one million square kilometers, the cultivable area is restricted to about 36,000 square kilometers located mainly along the Nile. Egyption population is growing at a rate of 2.5 percent per year. The constant fall in the ratio of land per person has exerted a dominant influence on the direction and shape of economic development efforts. Emphasis has been recently placed on creating new industries while, at the same time, improving the yield per feddan and reclaiming additional land. Import policies have idled production capacity in both the industrial and agricultural sectors. However, because of the low level of private saving and the lack of substantial inflows of foreign capital, investment hovered at close to replacement levels. The lack of capital coupled with high rates of population growth make Egypt a classic example of a "poor" country.

The purpose of this chapter is to explore the concept of "labor surplus". An attempt will be made to prove that a "surplus of labor" does indeed exist in Egypt.

B. Population Growth

Egypt's population exhibits the typical demographic features of

the densely inhabited developing country. The rate of population growth rose from an average of 1.2 percent per year before the second world war to 2.5 percent in the 1970's--a result of a sharp fall in deaths not compensated for by a similar decline in birth rates.

Table 4-1 shows the acceleration in the rate of growth during the past three decades.

TABLE 4-1
POPULATION GROWTH IN EGYPT

Year	Population	Annual Compound Growth
1917	12,751,000	--
1927	14,218,000	1.09
1937	15,933,000	1.15
1947	19,022,000	1.78
1960	26,089,000	2.45
1966	30,139,000	2.54
1976	37,233,000	2.41

Source: Statistical Handbook U.A.R., 1976, p. 8.

Death rates, which have been substantially lower since World War II, have declined only gradually since the early 1950's, though they may have fallen more steeply in the mid-1970's. The rate of natural increase from the early 1950's to the mid-1960's rose as a consequence of virtually unchanging birth rates combined with slowly falling death rates. After 1960, the picture changed slightly and birth rates fell somewhat to reach a level of 37 per thousand (Table 4-2). In 1972, the rate of natural increase was about 2.4 percent. Subsequently, birth rates have risen, and this, combined with falling death rates, accounts for the sudden jump in the rate of natural increase.

TABLE 4-2.

BIRTHS, DEATHS, AND RATES OF NATURAL INCREASE OF POPULATION, 1950-54 to 1975

(Rate per Thousand)

Period[a]	Birthrate	Death rate	Natural Increase
1950-54	44.9	21.6	23.3
1955-59	44.0	19.9	24.1
1960-64	43.1	18.0	25.1
1965-69	41.1	15.8	25.3
1970-74	37.8	13.7	24.1
1972	36.9 (34.4)	13.2 (14.5)	23.7 (19.9)
1973	38.1 (35.1)	13.8 (12.9)	24.3 (22.2)
1974	36.8 (35.9)	13.0 (12.4)	23.8 (23.5)
1975	39.4 (37.7)	13.0 (12.2)	26.4 (25.5)

Note: The figures in parentheses are registered rates.

[a]The figures are five-year averages from 1950 to 1974

Source: Five year averages, UN Population Division; single years, Population and Family Planning Board, Egypt.

Life expectancy at birth is now about fifty-five years. Mortality rates are similar to those of other North African countries--well above those of South Asia and most of Latin American, and substantially below most of Africa. This might be expected in view of Egypt's degree of development as measured by its per capita income (U.S. $280 in 1976). Infant mortality is estimated to be about 116 per thousand live births--again, not unusual for a country of Egypt's income level.

One of the demographic features of the Egyptian population is the continuous migration from rural to urban areas. The principles governing this inflow are the accelerating rate of population growth, especially in rural areas, and income differentials between urban and rural areas. For most, migration is an effort to improve the standard of living. The provision of more employment opportunities depends both on the growth of the labor force and the increase in the level of economic activities. Migration plays an important role in determining the nature of labor supply and unemployment, where unemployment is not only tied to the inflow of labor from rural to urban areas, but also to the ability of the urban economy to provide enough employment to the newcomers. An examination of the variation in expenditure standards in both rural and urban areas would clarify the major reasons behind this inflow.

C. The Measurement of Variation in Expenditure Standards in Both Rural and Urban Areas

The extent of variation in expenditure patterns in rural and urban areas could be ascertained by several means. The Lorenz curve

is considered the most commonly used measure, and thus it may be used for comparing the variation in expenditure of the various groups for each of the selected three years (1959, 1965, 1975) as well as for comparing the variation in the expenditure of the same group, i.e., either rural or urban, throughout the different years (from 1958 to 1975).

While the Lorenz curve provides a graphic presentation of the variation degree, there are several means by which such a variation could be ascertained in numerical terms, e.g., the Gini co-efficients (Seal, 1974) which are based on the analytical logic of the Lorenz curve.

Figure 4-1 shows the Lorenz curve in relation to the distribution of total expenditures in urban and rural areas during each of the three years covering the period under review. These figures reveal the same results in respect of expenditure distribution within rural areas which have nearer equality than the distribution in urban areas. In the three cases, the curve is nearer the diagonal (or the line of equal distribution) in rural areas than in urban areas.

In light of developments which emerged in the size of variation in each of urban and rural areas separately, from Tables 4-3 and 4-4 it will be seen that 3.3 percent of urban families (high expenditure category) accounted for 15.3 percent of total expenditure in 1958-59. Meanwhile, 50.96 percent of families (low expenditure category) acquired 23.4 percent thereof. As for developments in 1964-65, families with high expenditure accounted for about 7.7

TABLE 4-3.

SIZE DISTRIBUTION OF HOUSEHOLD CONSUMPTION EXPENDITURE IN URBAN EGYPT

	1958/59	1964/65	1974/75
Share of:			
Lowest 40%	16.4	16.5	18.3
Lowest 60%	30.9	31.3	34.4
Middle 30%	38.7	38.0	38.0
Top 10%	30.4	30.8	27.6
Gini Coefficient	0.40	0.40	0.37

Source: Ibrahim El-Issawi, Interconnections Between Income Distribution and Economic Growth in the Context of Egypt's Econ-Development, 1979, p. 13.

TABLE 4-4.

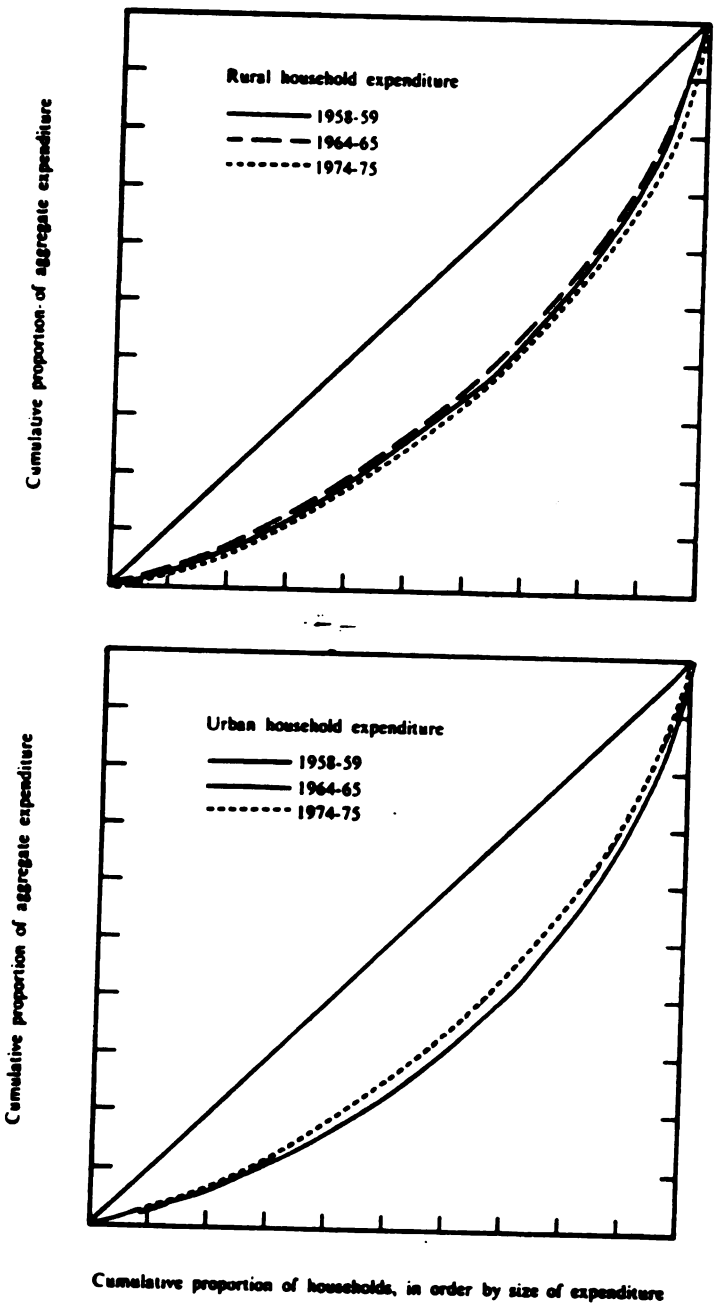
DISTRIBUTION OF RURAL HOUSEHOLD CONSUMPTION EXPENDITURE, 1958/59, 1964/65, and 1974/75

Percentage of Expenditure Accruing to:	1958/59	1964/65	1974/75	1977
Lowest 20%	6.35	6.95	5.80	5.40
Second 20%	11.29	11.85	11.27	10.90
Third 20%	15.65	16.07	15.71	15.70
Fourth 20%	22.78	22.41	21.09	22.80
Top 20%	43.93	42.72	46.13	45.20
Top 10%	28.22	27.52	31.01	29.00
Gini Coefficient (Average)	0.370	0.353	0.392	0.393

Source: John Waterberry, Patterns of Urban Growth and Income Distribution in Egypt. The Princeton-Egypt Income Distribution Project, 1980, p. 13.

FIGURE 4-1.

LORENZ CURVES FOR RURAL AND URBAN HOUSEHOLD EXPENDITURE, 1958-59 to 1974-75



Source: Osman A. el-Kholie, "Disparaties of Egyptian Personal Income Distribution as Reflected by Family Budget Data," L'Egypte Contemporaine, Vol. 64, No. 354 (October 1973); and Central Agency for Public Mobilization and Statistics.

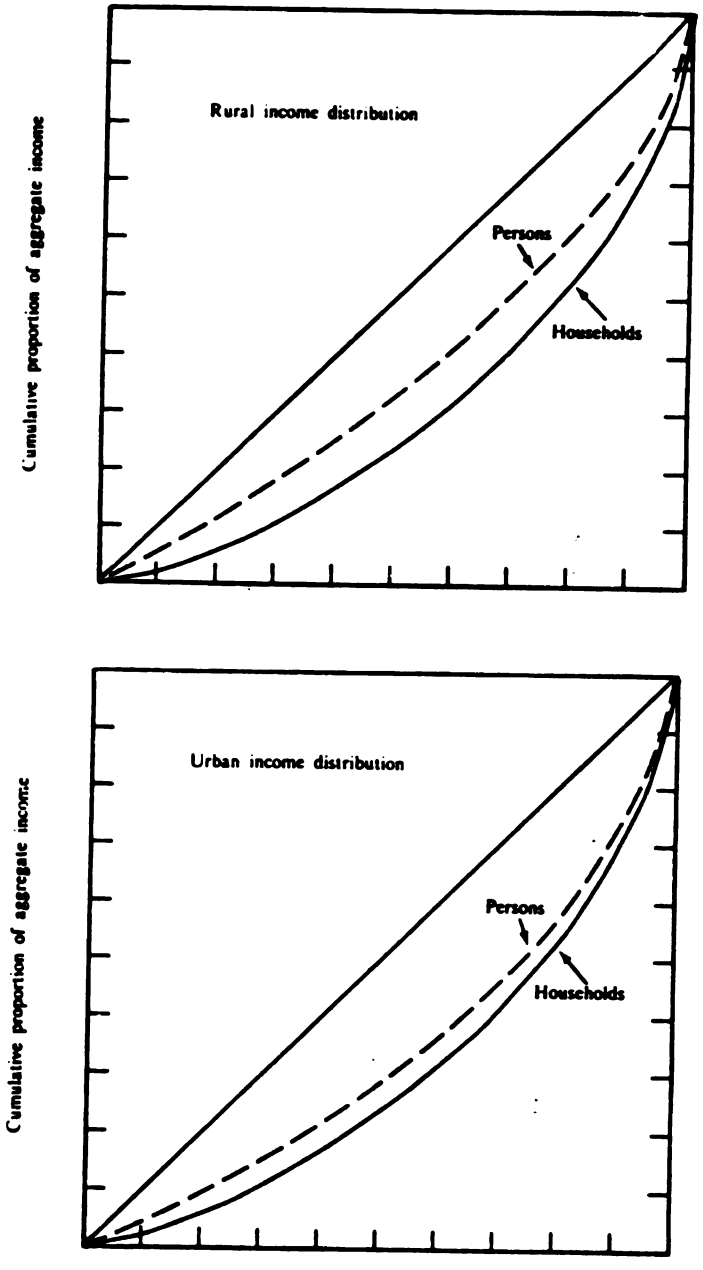
percent of total families and for 26.6 percent of expenditure. However, the situation changed in 1974-75, with rich families representing about 17.4 percent of the total and absorbing 40.1 percent of expenditure. These developments highlight the wide variation in expenditure during 1958-59. This pattern showed some moderation in 1964-65. Nevertheless, the variation widened once more in 1974-75 owing to the enlarged expenditure of some categories with high income.

As regards rural areas, the gap was not so large, as families with high expenditure in 1958-59 accounted for 0.3 percent of the total families and acquired about 2.4 percent of expenditure, whereas families with low incomes represented about 79.5 percent of the total with share of 55.4 percent of expenditure. The year 1964-65 witnessed some developments as the percentage of families with high incomes amounted to 1.3 percent and acquired about 7.3 percent of expenditure.

The above analysis suggests that expenditure distribution in rural areas was more equitable than in urban areas during the three years under review. Moreover, the development of income distribution within and between rural and urban areas indicates a sustained gap among various categories of expenditure. This variation in income distribution between rural and urban areas (Figure 4-2) is one of the major reasons for the high rate of migration from rural to urban centers.

FIGURE 4-2.

LORENZ CURVES FOR RURAL AND URBAN INCOME DISTRIBUTION
1974-75



Source: Osman A. Kholie, Ibid.

D. Labor Surplus

The classical theory of labor surplus stressed the need for additional manpower in the non-agriculture sector of a developing economy. In this capacity, agriculture was thought to play the role of "lender" of source for inputs, specifically labor. The sector was viewed as having for some time employed the labor resources available to it to the point that its marginal product was zero; therefore, agricultural labor could be transferred to the urban sector without any significant loss in agricultural output.

W. Arthur Lewis asserted that many underdeveloped countries conform to the classical model, in which the supply of labor is perfectly elastic at current wage rates (Lewis, 1954, p. 418). The "widow's curse" of workers consists of farmers, casual workers, petty traders, domestic retainers, and additions to the labor force through population growth. If one puts the whole growth process in time, however, as one must to get meaningful results, the Lewis model accords with reality in many underdeveloped countries. Egypt is one of these countries.

The Lewis argument requires three conditions:

1) The wage rate in the industrial sector must be above the marginal productivity of labor in the rural sector by some small but fixed amount;
2) The investment in the industrial sector must not be absolutely large relative to population growth; and
3) The cost of training the necessary numbers of skilled workers must be constant through time.

Those conditions will be examined in relation to the Egyptian agriculture sector later on. However, for the general case of underdeveloped countries, Professor Benjamin Higgins suggests that "the supply of unskilled labor to the industrial sector can be treated as perfectly elastic" (Higgins, 1958, p. 306). Furthermore, he argues that the labor supply in rural areas is "redundant" in the sense that marginal productivity there is below the subsistence standard of living. His argument is based on the assertion that the first condition seems to be met in many countries. If the "population multiplier" operates, population growth being accelerated by the very process of industrialization, the second condition is automatically guaranteed. But even if industrial investment does actually exceed population growth, the second condition can be met if employment in the industrial sector is a small proportion of the total and population growth is fairly high. To demonstrate this, he gives an example: suppose that the labor force is twenty million, that four million are employed in the industrial sector, that the capital-job ratio in that sector is $2,000 per man, and that the labor force grows at a rate of 2 percent per year. To employ the total increase in the labor force in the industrial sector would require net investment of $800 million next year, or ten percent of the total stock of capital. Net investment on this scale would double the stock of capital in about seven years, a rate of growth beyond the wildest dreams of most underdeveloped countries. For the third condition, Lewis argues that labor skills are only a "quasi-bottleneck;" if you have unskilled workers, you can convert

them into skilled ones. Lewis' argument can be accepted in the short run if the costs of training unskilled workers is constant. However, if we think in terms of long run supply through time, the relevant question about the supply of skills is whether the cost of training is rising through time. The answer, of course, will depend on the nature of technological progress. If the progress reduces both the capital-labor ratio and the capital-output ratio simultaneously, the Lewis thesis may hold for skilled labor as well as for unskilled.

The neoclassical literature on labor surplus that developed in the 1960's abandoned the assumption of zero marginal product. It focused instead on the divergence of wage rates and marginal products between agriculture and non-agriculture, which were viewed as evidence of dualistic disequilibrium.

E. Growth of the Egyptian Labor Force

The role of population growth and the labor force participation rate of different population cohorts jointly determine the rate of growth in the labor force. Making only minimal allowance for changes in the labor force participation rate over time, Table 4-5 shows the rate of growth of the labor force in Egypt in comparison with aggregate growth rates of the labor force in developed countries. The table dramatically illustrates the problem confronting Egypt. On the average, the labor force grows at 2.5 percent annually, which is more than double the rate of the DC's, implying a total increase of about 28 percent for the decade 1970-

TABLE 4-5.

GROWTH OF THE EGYPTIAN LABOR FORCE

Year	Egyptian Labor Force	Rate of Growth	DC's Rate of Growth
1960	6.7		
		3.3	1.5
1965	7.9		
		2.4	1.7
1970	8.9		
		2.15	2.2
1975	9.9		
		2.8	2.3
1980	11.4		

Source: Data from Population Census, and Turnham, D., 1971, The Employment Problem in Less Developed Countries.

1980. Starting from 1950, the rate of growth of the Egyptian labor force passed the two percent mark and has been consistently increasing.

F. Labor Force Participation Rates

A person is defined as employed if he works a specified minimum number of hours during the week in which the employment census is taken. The "amount" of work sufficient to characterize one as employed, therefore, becomes a source of ambiguity in labor statistics. Persons are defined as unemployed (in the involuntary sense) if they do not have a job but are actively seeking one. This is again a subject of considerable ambiguity. The labor force participation rate is the ratio of persons at work, or seeking work, in a given population group. Given the size and age structure of the population, therefore, the participation rates determine the size of the labor force. If the participation rate does not change, the labor force will grow by the same percentage as the total population.

Participation rates may vary substantially from country to country and from sector to sector, generally ranging from .25 to .50. Variations in the labor force participation rate can be explained by a number of reasons, economic as well as non-economic. One important factor is the age structure of the population. The more the age structure is skewed toward young age groups, the lower the participation rates (Table 4-6).

TABLE 4-6.
AGE STRUCTURE OF THE POPULATION

Age Group	1947	1960	1976
0 - 9	26.4	36.0	33.3
11 - 19	21.7	15.7	19.2
20 - 29	15.1	12.8	14.1
30 - 39	13.8	12.6	11.3
40 - 49	10.4	9.6	8.7
50 and over	12.7	13.6	14.4

Source: Population Censes, U.A.R., 1977.

The Egyptian population has become younger than before. The average age of the population has fallen from 25.8 years in 1947 to 24.4 years in 1960, to 24 in 1976, as can be seen from the table. This means that the dependency ratio has increased, i.e.,for every ten people between 15 and 60 years of age, there are 8.5 children under 15. This, of course, has an adverse effect on saving and investment because of the increase in consumption.

The participation rate, however, remained fairly constant at the same low level because the slight decline for males has been

compensated by a slight increase in female participation. The following table shows the unadjusted activity rates of urban and rural areas by sex.

TABLE 4-7.
CRUDE ACTIVITY RATES OF URBAN AND RURAL AREAS

Sex	1960	1976	Change
		Urban Areas	
Males	49.0	51.3	2.3
Females	5.8	8.1	2.3
Total	27.8	30.2	2.4
		Rural Areas	
Males	59.0	56.9	-2.1
Females	4.3	3.5	-0.8
Total	31.6	30.5	-1.1
		Total	
Males	55.1	54.4	-0.7
Females	4.8	5.5	+0.7
Total	30.1	30.4	+0.3

Source: Population Census, and Ibrahim Issowi paper, 1976

The table shows that the total labor force grew at almost the same rate as the population during the period 1960-1976. The crude, overall participation rates have accordingly remained almost constant, increasing only from 30.1 percent of total population in 1960 to 30.4 percent in 1976. Behind this almost constant participation rate we find, however, a substantial increase in the urban rate from 27.8 to 30.2 percent, with a fall in the rural rate from 31.6 to 30.5 percent; and a fall in male participation from 55.1 to 54.4 percent, with an increase in female participation from 4.8 to 5.5 percent. Thus, an increase in urban male participation is more than

balanced by a decline in rural male participation; a fall in rural female participation is more than balanced by increased urban female participation. The changes in the urban-rural, male-female participation patterns are partly due to migration from rural to urban areas. This is due to the surplus of labor in agriculture and government policies of employment, which will be discussed later, and finally it is due to education, where an undereducated person drops out of the labor force. Educated persons, on the other hand, tend to have higher participation rates than uneducated persons; this is true in particular for females. Thus, in the age groups 15 to 29, male participation has fallen; in the age groups 30 to 59, it has risen. For females, the age groups 10-19 show a fall. The age groups 20-34 show an increase. For older people, males and females, there is a fall in labor force participation from 1960 to 1976.

G. Unemployment

Unemployment was defined in terms of those without full-time employment who actively sought work in the week before the survey. Despite this rather restrictive definition, unemployment is very high even taking at face value the official statistics, which are traditionally biased downward for political reasons. The following Table 4-8 shows labor force, employment, and unemployment for 1960-1976. The table shows unemployment in 1976 at 7.7 percent. This high number, however, does not reflect the real picture of unemployment in Egypt for two reasons:

TABLE 4-8.
EMPLOYMENT AND UNEMPLOYMENT RATES

	1960	1976	% Rate of Growth
Population Total	25,841	36,626	2.20
Manpower Basis, total*	17,436	25,580	2.42
Labor Force	7,822	11,037	2.18
Employed	7,647	10,190	1.18
Unemployed	174	847	10.4

Source: Population Census, Ministry of Planning Information

*Manpower base is defined as population above age 15 and under 65, excluding disabled persons.

1. External migration

In recent years, Egypt experienced a tremendous increase in the scale of movement of members of the working force abroad. The number of emigrants abroad in 1965 was recorded as 100,000. The figure revealed by 1976 census reached 1,425,000. While the early movement of labor abroad was limited to teachers and other high technical professions (e.g., doctors and engineers), the movement in the 70's covered the whole occupational spectrum. All types of skilled as well as unskilled labor were involved. There is much uncertainty about the number of emigrants. The 1976 population census claims to have identified about 1.4 million, of which 1 million are assumed to be economically active abroad.

If an emigrant were not in the labor force while in Egypt, his departure would have no direct effect on labor force employment or measured unemployment. We can take it, therefore, that emigrants

economically active abroad have reduced the domestic labor force by their number. We can also assume that they have reduced unemployment by the same number. This is obvious if, before emigration, the employer would hire replacements and unemployment would fall.

In the absence of emigration, labor force and unemployment would have increased by about 1 million more than the actual increase from 1960 to 1976. The actual development from 1960 to 1976

Increase in employment	2,543,000
Increase in unemployment	673,000
Increase in the labor force	3,216,000

would have been replaced by

Increase in employment	2,543,000 - 1,000,000 = 1,543,000
Increase in unemployment	673,000 + 1,000,000 + 1,000,000 = 2,673,000
	4,216,000

implying an unemployment rate of 25.8 percent in 1976. In this calculation, we have not considered redundance in public enterprises and demand effects which could only aggravate the situation. However, this number is most likely biased upward since there is no valid reason for the assumption that all emigrants would have been unemployed in the absence of emigration.

2. Labor redundancies

The government sector is characterized by large redundancies of unskilled labor. The most important employment-generating government policies have been the expansion of and overstaffing in the public sector, government as well as public enterprises. The schemes

of guaranteed employment for university and other graduates and for military conscripts have greatly contributed to this result.

A public employment drive was undertaken after the great nationalizations of 1961-62. Working hours in public enterprises were officially cut back from 48 to 42 per week and new employees hired. The employment guarantee for graduates originated in Law No. 14, 1964, and was made permanent by Law No. 85, 1973. With medical graduates outside the system, it extends the right to university graduates as well as two year and intermediate-level graudates, to apply for public employment three years after graduation. Once a year, the Ministry of Manpower and Vocational Training invites applications with specification of preferences from eligible graduates, and solicits at the same time requests from graduates from government agencies and enterprises. Since the latter automatically are provided with funds for financing appointments, requests exceed supply totally and for most specializations. Applications are usually approved, excess supplies being allocated to local authorities (governorates) for their discretionary disposal. Apart from certain specified specializations in very short supply, public authorities are not permitted to hire graduates until two or three years after graduation and then through the system just described. Graduates who succeed in obtaining private employment may line up for guaranteed public employment. The system, in combination with a rigid public wage grade system, tends to imply that the best qualified graduates get private employment (at salaries above those for beginning public employees) while government and public enterprises are saddled with

the least qualified graduates. The policy has recently been terminated insofar as public enterprises are concerned, with increased appointments in government as the consequence.

The employment guarantee for military conscripts was introduced in the early 1960's and apparently abrogated in 1978. It gave demobilized conscripts the option of public employment. It is not clear whether the abrogation was limited to public enterprises (as was the case for graduates), whether it was retroactive or if conscripts entering the armed forces before 1978 still benefit from the guarantee. Non-graduate conscripts consist almost exclusively of unskilled young males, predominantly drawn from rural areas. The very large numbers of illiterates employed by the government as messengers, janitors, cleaning personnel, etc., may have obtained public employment in this way.

Table 4-9 provides a picture of employment by economic sector. Military conscripts are included and recorded in their sector of origin; conscripts not in the labor force at the time of drafting are probably included as "not adequately described."

In terms of annual growth rates of employment, government and construction stand out as leading sectors, with manufacturing in third place. In terms of absorption of the increase in total labor force, again the government is leading with manufacturing and agriculture in second and third places, respectively, absorption being the combined result of sector size and growth rates.

The more recent developments for 1971-79 are shown in Table 4-10, which is based on LFS. The government is shown separately.

TABLE 4-9.

EMPLOYMENT BY ECONOMIC ACTIVITY

Industry	# of person 000 1960	1976	% Annual rates of growth	Shares of total % 1960	1976	Shares of increase 1960 - 1976 #	%
1. Agriculture,fish	4,406.3	4,881.0	0.6	65.3	43.8	474.7	14.4
2. Mining quarries	21.2	33.8	3.0	1.3	0.3	12.6	0.4
3. Manufacturing	647.2	1,369.5	4.7	8.3	12.3	722.3	21.9
4. Electricity,gas	16.9	61.8	8.3	0.2	0.6	44.9	1.4
5. Construction	158.9	425.1	6.3	2.0	3.8	266.2	8.1
6. Trade, etc.	690.8	861.3	1.4	8.8	7.7	170.5	5.2
7. Transportation	260.2	482.3	3.9	3.3	4.3	222.1	6.7
8. Financing	72.5	88.4	1.2	0.9	0.8	15.9	0.5
9. Services	1,333.3	1,868.3	2.1	17.0	16.8	535.0	16.2
10. Not adequately described	224.7	1,060.3	10.1	2.9	9.5	835.5	25.?
Total	7,832.0	11,131.6	2.2	100.0	100.0	3,299.6	100.0

Source: Population Census adjusted for comparability, see A. Nassef, 1980.

TABLE 4-10.

EMPLOYMENT BY ECONOMIC ACTIVITY

Industry	# of persons .000 1971	1979	Annual rate of growth %	Shares of total 1971	1979	Shares of increase in employment # .000	%
1. Agriculture, fish	4,469.4	4,002.0	-1.4	54.2	41.8	-467.5	-35.6
2. Mining	7.2	22.8	15.5	0.1	0.3	15.6	1.9
3. Manufacturing	1,030.2	1,531.9	5.0	12.5	16.0	501.7	38.2
4. Electricity,gas	25.8	65.7	12.4	0.3	0.7	39.9	3.0
5. Construction	193.2	448.5	11.1	2.3	0.7	255.3	19.4
6. Trade, etc.	797.2	488.4	1.8	9.7	9.6	121.0	9.2
7. Transportation, Communication	323.1	488.4	5.3	3.9	5.1	165.3	12.6
8. Finance, etc.	83.2	116.8	4.3	1.0	1.2	33.6	2.6
9. Services	1,268.7	1,820.7	4.6	15.4	19.0	551.7	42.0
10. Unspecified	54.2	150.4	13.6	0.7	1.6	95.2	7.3
Total	8,252.5	9,565.3	1.8	100.0	100.0	1,312.8	100.0
Of which government	1,270.5	2,065.3	7.2	15.4	21.9	794.8	60.5

Source: Labor Force Surveys, Ministry of Planning, 1979.

H. Surplus Labor in Agriculture

Agriculture accounts not only for more than 25 percent of GDP, but also for about 45 percent of total employment. The production performance of agriculture over the period 1965-1975 is presented in Table 4-11.

Although total output continued to increase, the annual rate of growth of agricultural production dropped from 4 percent during the 1960's to about 2 percent by the end of the decade. The accuracy of these figures cannot be firmly established, since the Egyptian agricultural production value data are available only in current prices. The Food and Agriculture Organization (FAO) and the United States Department of Agriculture (USDA), however, publish production indices for Egypt based on 1960-65 prices. The FAO index shows a 1.7 percent annual increase in total agricultural production between 1965 and 1974. Thus, both indices indicate a slowdown after 1965. Since the population grew at an annual rate of 2.5 percent during this period, both indices indicate a declining level of per capita agricultural production. This resulted in a large increase in food imports.

The effect of population growth is the growing pressure on cultivable land, on both cultivated and cropped areas (that is, the area cultivated multiplied by the cropping intensity), since the late nineteenth century, and the decline in the number of feddans per capita during this period. The growth in the size of the areas has slowed in recent years, and no significant increase can be expected. In spite of the massive exodus from the villages, the

TABLE 4-11.

VALUE OF AGRICULTURAL PRODUCTION, COSTS OF INPUTS AND VALUE ADDED IN CURRENT PRICES IN MILLIONS OF EGYPTIAN POUNDS

Item	65	66	67	68	69	70	71	72	73	74
Value of agricultural products										
Plant production	589	643	650	693	747	770	897	905	1,036	1,279
Animal Production	212	230	253	208	223	278	269	318	315	--
Total	801	873	903	901	970	1,048	1,123	1,223	1,391	--
Costs of Inputs										
Seeds	25	27	28	30	28	30	30	30	33	45
Chemical fertilizer	38	41	41	39	41	49	44	49	49	53
Fuel	5	6	6	9	9	9	9	9	10	9
Green feeds	64	65	76	106	110	112	149	155	192	231
Straw	22	30	16	14	14	21	18	19	25	44
Concentrates	17	18	17	16	14	17	17	17	18	21
Insecticides	11	10	15	9	12	14	23	20	18	22
Depreciation	6	6	6	7	7	7	8	9	9	10
Others	1	1	1	1	6	6	8	10	16	14
Total	189	204	206	231	241	165	306	318	371	458

Source: Ministry of Agriculture, U.A.R., 1976.

absolute number of inhabitants classified as rural continues to grow. It was about 18 million in 1966; ten years later it was 20.6 million.

In the following section, we will examine productivity and unemployment in agriculture. Arthur Lewis' conditions for surplus of labor will be examined in order to find if the Egyptian agricultural sector conforms to his model. Furthermore, some empirical results concerning labor surplus will be discussed.

1. Unemployment and productivity

Agricultural unemployment has attracted a good deal of special attention at the level of both theory and measurement. In general, there is no widespread "unemployment" in rural areas during peak seasons, but since working days in agriculture range from a high of over 100 million in June to a low of less than 30 million in January in 1976 (Table 4-12), it is obvious that a large amount of seasonal unemployment does exist.

TABLE 4-12.
NUMBER OF WORKING DAYS IN AGRICULTURE - 1976

Month	Number of Working Days (thousands)
January	27,100
February	39,200
March	33,600
April	51,800
May	68,200
June	105,500
July	69,400
August	32,700
September	80,500
October	47,100
November	32,900
December	33,600
Total	621,600

Source: Agriculture Research Center, Ministry of Agriculture, 1976.

The table shows that only during the month of June is the labor force in agriculture fully employed. During eight months of the year, an average of only 37 percent of the agricultural workers are employed.

The question of productivity is by far the most studied, and the least agreed upon. The controversy surrounds not only the definition of the concept but also its measurement. A comparison of the composition of employment with the distribution of gross domestic product according to economic activities, yields some interesting inferences about labor productivity in each sector. Sector distribution of employment and GDP are shown in Tables 4-13 and 4-14.

The tables show that the share of agriculture from the civilian labor force is declining steady, from 57 percent in 1960 to 41.8 percent in 1978. (The absolute number of agriculture labor continues to grow, from 18 million in 1966 to 20 million in 1978). But even with the decline, agriculture is still by far the leading sector in employment. However, Table 4-14 confirms the most striking facts: that although agriculture is the leading sector in employment, its contribution to GDP is not only smaller than its share of employment, but the contribution is declining steadily, from 32 percent in 1961 to 25 percent in 1978. Such relative ratios could be interpreted as indications of low productivity in agriculture.

The estimate of marginal productivity can answer the question, how low is the productivity of the Egyptian agricultural sector?

TABLE 4-13.

DISTRIBUTION OF GDP BY ECONOMIC ACTIVITIES
% AT CONSTANT PRICES

Sector	1955-56	1961	1970	1976	1978
Agriculture	34	32	28	28	25
Manufac-turing	18	20	21	22	24
Electricity	--	1	2	2	2
Construction	2	3	5	5	5
Transporta-tion	6	7	5	8	9
Trade & Finance	11	10	9	13	13
Housing	7	6	5	2	2
Other Services	22	21	25	20	20
Total	100	100	100	100	100

Note: 1955-70 at 1964 prices, 1970-75 at 1970 prices, 1975 at 1975 prices.
Source: Ministry of Planning, 1959/60-1975; World Bank Report, 1975-79.

TABLE 4-14.

CIVILIAN EMPLOYMENT BY ECONOMIC ACTIVITY %

Sector	1960	1971	1976	1978
Agriculture	57.0	53.0	43.9	41.8
Manufacturing	9.5	12.4	12.6	16.3
Electricity	0.5	0.3	0.5	0.7
Construction	2.0	2.3	4.5	4.7
Transportation	3.4	3.9	4.4	5.1
Trade & Finance	8.3	9.6	10.6	10.8
Other services	19.3	18.3	23.6	20.6

Source: Population Census, 1960, 1966, 1976
Labor Force Sample Survey.

One way of estimating marginal productivity is by dividing the absolute change in the value added in the agricultural sector by the absolute change in the number of agricultural workers. The estimates for a selected number of years are as follows:

TABLE 4-15.

MARGINAL PRODUCTIVITIES FOR SELECTED YEARS

Year	1971	1973	1974	1975
Marginal Productivity	0.6	0.3	0.2	0.3

Source: National Bank of Egypt, 1976

It is obvious from those estimates that marginal productivity is not only very low but perhaps has also taken a downward trend.

The zero marginal product concept can be interpreted in two ways: 1) that labor is working without contributing anything to output; 2) that some workers are marginal in the sense that removing them from the farms would stimulate the remaining workers to compensate for the loss in output by working harder. The implication of zero marginal productivity is that removal of labor is costless to the agricultural sector. Marginal productivity in the agriculture sector in Egypt has never been zero, but is low enough so one can draw the conclusion that it is close to zero in the second sense. Neoclassical advocates (Jorgenson, 1960) stress the point that there is no surplus of labor that can be transferred from agriculture at no loss of output, except under rather special circumstances. Nevertheless, the agriculture sector in Egypt

did not experience a loss of output as a result of labor migration to the urban sector. However, the share of agricultural output in GDP declined. One explanation for the decline in agricultural contribution is the low productivity of agricultural labor, as we have shown earlier. Lower labor productivity can be attributed mainly to the lack of investment in agriculture, which is reflected in a very low capital labor ratio.

2. Wage differentials

Wage differentials in Egypt are large, as they are in most developing countries. Table 4-16 shows wage rates on a daily basis in some major sectors in 1966 and 1975. The differential between averages for agricultural laborers and employees in manufacturing remains large.

TABLE 4-16.

COMPARISON BETWEEN AGRICULTURAL AND INDUSTRIAL WAGE RATES

Year	Agriculture Average Daily Money Wage PT/man	Cost of Living Index	Manufacture Average Daily Money Wage PT/man	Real Wage in Agriculture
1966	25.0	139	183.2	144
1970	25.0	170	191.8	118
1975	46.5	242	297.1	154
1978	88.5	340	314.5	208

Note: 1960 is the base year.

Source: Money wage rates, Ministry of Agriculture.
Cost of living index refers to cost of living index for rural areas published by CAPMAS in The Monthly Bulletin.

The immediate impression given by the table is one of improvement in wages (in agriculture) over the period under consideration. This observation has to be qualified, however. First, the rise in

money wages was largely wiped out by inflation, and it was not until the mid-1970's that real wages began to rise. It should also be noted that real wages show seasonal fluctuations within the year, reaching their peak around July and bottom around February. This observation has important implications for the pattern of income permanence for wage earners. The drop in the real wage during the slack season coupled with inflation tends to wipe out any gain in money wages. Moreover, the increase in money wages was more sluggish than that of value added in agriculture, thus suggesting a proportionately higher share of the increase in value added occurring to returns on property than to labor. It should also be noted that, given the structure of income sources in rural Egypt, this improvement in real wages would affect only a small percent (about 12 percent) of total income source.

It may also be of interest to take a look at Arthur Lewis' last two hypotheses concerning labor surplus. We find first: average wage per worker in manufacturing does exceed average productivity in agriculture, as shown in Table 4-17.

Regarding investment policies, we find that while 17 percent of total gross investment went to agriculture in 1960, the corresponding figure was 8 percent in 1979. The share of manufacturing for the same year declined from 25 to 19 percent. Investment in manufacture is not large by any means, especially in comparison to population growth. In fact, the trend of investment in manufacture is downward, where population growth keeps rising at a high rate.

TABLE 4-17.

WAGES AND PRODUCTIVITY IN AGRICULTURE

Year	Agriculture Productivity per Worker per Year	Manufacture Average Wage Per Worker
1966	156.9	183.2
1970	190.7	191.8
1975	271.0	297.1
1978	290.8	314.5

Source: As above.

Chapter 5

Model Estimation for Egypt

A. Introduction

In this chapter, the results of CD are presented. The estimates are used as a starting point for estimating labor and capital productivities. The results are summarized in Tables 5-2 and 5-3. The estimates for labor are disaggregated to annual marginal productivity per worker per year and to marginal productivity per worker per week and per hour. Recall that technological changes are assumed to be the same throughout the economy. The hypotheses that need to be verified in this chapter are: (1) Egyptian labor productivity is low relative to that of other LDC's and relative to the productivity of labor in Libya; (2) resources are not allocated efficiently in Egypt, in particular labor; and (3) the reallocation of resources to and from Egypt would increase the overall productivity of both capital and labor.

Among the results of interest to be discussed are the following: (1) estimates of CD production function for Egypt as an approximation to the production process; (2) productivity measurements; (3) factor intensity; (4) the elasticity of substitution between capital and labor; (5) AES and income shares; (6) policy implications of resource allocation; (7) allocative efficiency; and (8) optimum level of the Egyptian labor force.

B. Estimates of CD Production Function for Egypt

A production function in a typical Harrod-Domar model would take the form

$$Y_t = \min (\alpha L, \beta K_t).$$

The parameters α, β represent the average output-labor ratio and output-capital ratio, respectively.

For developed countries, population growth and technical progress are usually assumed to be the limiting factors, since the "natural" rate of population growth never seems to exceed the maximum possible rate of capital accumulation. Under these circumstances, a production function will serve as a labor requirements equation. For developing countries, the reverse is assumed to be true; that is, labor is abundant and capital is generally scarce. A production function for a developing economy will therefore exhibit the capital argument as the only binding argument in the factor-output relationship. The case of Egypt falls in the second category.

A production function of the CD variety was employed and tested. The results were as follows:

$$\log Q_t = \underset{}{17.8} - \underset{(2.08)}{1.23} \log L + \underset{(1.27)}{.226} \log K + \underset{(2.60)}{.063} \log T \qquad 5.1$$
$$\bar{R}^2 = .92 \qquad (2.60)$$

The disembodied technological changes in equation 5.1 are accounted for by the variable T. The variable T is significant at a significance level of 5 percent, which probably implies that technological changes have not been neutral during the period 1962-1977.

It can be seen from equation 5.1 that the labor coefficient not only is not significant, but also has a wrong sign. Since a negative coefficient suggests negative contribution to output, the assumption of technological changes was abandoned, and the equation was estimated without the independent variable T. The estimated result is:

$$\log Q_t = \underset{(-1.60)}{-4.11} + \underset{(3.78)}{2.11} \log L + \underset{(3.76)}{.285} \log K \quad \bar{R}^2 = .89 \qquad 5.2$$

The coefficients of labor and capital are both significant. Equation 5.2 shows that a one percent increase in labor or capital will increase output by 1.22 or .285 percent, respectively.

When the constant term was dropped for lack of significance (restricting the function to pass through the origin), the result was

$$\log Q_t = \underset{(14.9)}{.698} \log L + \underset{(6.2)}{.368} \log K \qquad 5.3$$

From equation 5.3, it can be seen that labor and capital coefficients are highly significant.

As mentioned earlier, in the absence of reliable data on capital stock, adjusted gross capital formation (ΣI_t) was substituted for K. Lagging AGCF one year and re-estimating the equation obtained the following results:

$$\log Q_t = \underset{(-2.18)}{-7.66} + \underset{(3.65)}{1.66} \log L + \underset{(2.00)}{.223} \log K_{t-1} \quad \bar{R}^2 = .82 \qquad 5.4$$

The results of equation 5.4 are the same as those of equation 5.2, except for slight changes in the proportion of the coefficients.

The labor coefficient increased slightly, and the capital coefficient declined slightly. Notice also that the capital coefficient became marginally significant.

Equation 5.2 has a Durbin-Watson statistic of 1.22, which is an indication of an autocorrelation problem. Adjusting for this (by Cochrane-Orcutt method of first differences), the estimate is

$$\log Q_t = \underset{(0.92)}{-2.94} + \underset{(2.60)}{1.07} \log L + \underset{(3.28)}{.305} \log K \quad \bar{R}^2 = .98 \qquad 5.5$$

D.W. = 1.8

Although this result is subject to adjustment pending better estimates of capital stock, it should not be lightly dismissed. It does show that (1) the Egyptian economy as a whole is labor-intensive; (2) the Egyptian economy experienced increasing returns to scale during the period 1962-1977; and (3) technological changes seemed not to be neutral during the period under consideration. In the next section, the estimates for the production function will be used as the starting point for productivity estimates of capital and labor in Egypt.

Returning to the concept of technological changes, the inference from equation 5.1 that such changes have been non-neutral is not a comfortable one because the equation does not represent a good fit overall. If, instead, we want to test the hypothesis that technological change is embodied, that is introduced in the variable itself, this can be accomplished by redefining the units in which the inputs are measured. Two cases of neutral but embodied technological changes are tested.

The Harrod-Neutral technological change occurs when the change

is embodied in the labor input; thus

$$Q_t = f(K, \alpha(t)L) \qquad 5.6$$

where

$$L = \alpha(t)L.$$

The production function fitted for the period with labor, augmented labor (AL), and capital as the dependent variables resulted in:

$$\text{Log } Q = \underset{}{-9.24} + \underset{(0.70)}{2.34} \log L + \underset{(0.97)}{.42} \log K - \underset{(2.60)}{.10} \log AL + \underset{(1.70)}{.65} T \qquad 5.7 \qquad \underset{(2.47)}{}$$

$$\bar{R}^2 = .98$$

The coefficient of factor augmentation in equation 5.7 is not significant. This can be interpreted as a rejection of the hypothesis that technological changes are labor augmented.

The Solow-Neutral technological change occurs when the change is embodied in the capital input. This can be represented as:

$$Q_t = f(\beta(t)K, L) \qquad 5.8$$

The production function fitted with labor, capital, and augmented capital (AK), as the dependent variables resulted in:

$$\text{Log } Q = \underset{}{-11.6} + \underset{(1.20)}{2.52} \log L + \underset{(1.52)}{.67} \log K - \underset{(5.54)}{.034} \log AK + \underset{(2.60)}{.27} T \qquad 5.9 \qquad \underset{(5.90)}{}$$

$$\bar{R}^2 = .99$$

The coefficient of factor augmentation in equation 5.9 is significant. This can be interpreted as acceptance of the hypothesis that technological changes are capital augmented. However, because the coefficient has a negative sign, which implies that the change con-

tributes negatively to output, the result drawn from equation 5.9 is inconclusive. Another attempt was made to test for factor augmentation (Nelson's formulation, 1964). The function estimated is the following:

$$\text{Log } Q_t = C + a \log L + b \log K + \alpha \log AL + \beta \log AK + \gamma T \qquad 5.10$$

where α and β are the coefficients of factor augmentation. The implication is that technological advance "augments" new inputs so that they become more efficient than old inputs. The estimate of equation 5.10 was:

$$\begin{aligned}\text{Log } Q = {} & -4.29 + \underset{(0.37)}{.97} \log L + \underset{(0.44)}{.96} \log K + \underset{(3.97)}{.13} \log AL - \underset{(1.08)}{.07} \log AK - \\ & \underset{(2.13)}{.28\ T} \qquad \bar{R}^2 = .98 \qquad 5.11\end{aligned}$$
$$(.056)$$

Equation 5.11 confirms the results obtained from equations 5.7 and 5.9. Based on these results, the hypothesis of embodied technological changes is rejected. As we see later, both the ratio of marginal productivities of capital and labor and their respective shares change over time, which reinforces the notion that technology has been non-neutral throughout the period under consideration.

C. Productivity Measurement for Egypt

Changes in the elasticity of substitution are more difficult to measure and generally bring mixed blessings. Therefore, the parameter whose change offers the most alluring benefits from both the conceptual and the measurement point of view is technical efficiency (or total factor productivity).

Abstracting from changes in economies of scale and the ease of substitution, it has been suggested (Kendrick, 1973, p. 31) that increases in factor productivity could be measured by simply subtracting the increase in real output. If the indices of the different inputs could be weighted in some reasonable way (for example, by their relative contribution to output in base year), it would seem that even a rough index of the growth in real inputs and output would be sufficient for estimating the changes in output attributable to increasing factor inputs. By subtracting this component from the actual increase in output, one could estimate the increase in total factor productivity.

Total factor may be viewed as the relationship between real product and real tangible factor cost. The measures flow directly from the national income and product accounts in the aggregate and by sector and industry. If, as is customary, GNP or NNP estimates at market prices are deflated by market price indices, the resulting real product estimates may be reduced by the base period ratio of indirect business taxes less subsidies to gross or net product in order to approximate real product at factor cost.

The application of base-period factor compensation weights to factor input units, unadjusted for changes in quality or efficiency, results in a productivity ratio with the following general meaning. Real product in the given year indicates what the factor cost requirements would have been, assuming the base period conditions of productive efficiency, compared with what they actually were (given year real factor cost), reflecting the effects of technological change

and other variables affecting productive efficiency. Or, to state the same notion differently, the productivity ratio indicates the relation of real product in the given year to the real product that would have been produced (real factor cost) if the productive efficiency of the factors had been the same in the given year as in the base year.

Our measure of productivity is the index number of the ratio of real product to real factor cost (see Table 5-1). The index number for total factor productivity in 1977 (1965 = 100) was 115.0, which means an average annual rate of increase of 1.2 percent. This is approximately equal to the difference between the rates of change in real product (7.3) and in real factor cost (6).

Note also that since NNP at factor cost and national income are equal in current prices, the total factor productivity ratio must equal the ratio of the factor cost deflator to the product price deflator (column 3, line 4 ÷ line 2 = line 3 ÷ line 5). Another way of looking at this relationship is to see that factor prices rise by more than product prices to the degree that total factor productivity advances. "In fact, this is the means by which the market distributes productivity gains" (Kendrick, p. 33). The relationship also indicates that the impact of the rise in factor prices on product prices is offset to the degree that productivity advances.

The previous measure gives us the productivity trend of all inputs. However, what we are looking for is the distribution of this increment between factors of production, specifically the marginal productivity of labor and capital. One such method is the

TABLE 5-1

CHANGES IN REAL PRODUCT, FACTOR COST, AND PRODUCTIVITY 1965 - 1977

	1962 million $	1977 million $	Index 1965=100	Average annual rate of change
1. Net product at factor cost	2063.2	7552.7	366.1	11.4
2. Implicit product price deflator 1 ÷ 3			157.3	3.8
3. Real product	2063.2	4801.5	232.7	7.3
4. Implicit factor price deflator 1 ÷ 5			180.0	5.0
5. Real factor cost	2063.2	4195.9	203.4	6.0
6. Total factor productivity 3 ÷ 5			115.0	1.2
7. Factor product price 4 ÷ 2			115.0	1.2
8. Productivity increment 3 - 5		605.6		

Source: Yearly Book of Statistics, United Nations, 1977, pp. 74-75. Also, lines 1 and 2 obtained from National Book of Egypt, Arabic, 1977.

arithmetic index of productivity, introduced by Abramovitz (1956) and J.W. Kendrick (1961). It expresses all variables of an underlying production function as index numbers with a common base period and appropriate weights. The productivity index, C, is defined as

$$C = \frac{\frac{Q}{Q_o}}{\frac{P_{Ko}K_o}{Q_o}\left(\frac{K}{K_o}\right) + \frac{P_{Lo}L_o}{Q_o}\left(\frac{L}{L_o}\right)} = \frac{Q}{P_{Ko}K + P_{Lo}L} \qquad 5.12$$

where Q/Q_o, K/K_o, and L/L_o are indices of output, capital, and labor, respectively, and P_{ko} and P_{Lo} are the base year prices of capital and labor. The weights for capital and labor are their base year respective shares in output.

By rearranging terms, it can be seen that this index is based upon a production function in which output is a linear combination of the inputs,

$$Q = C(P_{ko}K + P_{Lo}L) \qquad 5.13$$

This function presents some uncomfortable theoretical problems. For example, differentiation of equation 5.12 shows that the marginal products of inputs change only through changes in the productivity constant, C; furthermore, their ratio (the marginal rate of substitution) remains the same regardless of how fast capital is growing in relation to labor. This is evident also ex hypothesi, since the arithmetic weights for capital and labor are their base period (constant) prices, and since theory suggests that under perfect competition marginal productivities are equal to the re-

spective input prices. An index of productivity that does not associate changes in marginal products with changes in input ratios (factor proportions) is a rather limiting index because it would be difficult to think of a better reason for changes in marginal productivities than changes in factor proportions.

Kendrick attempts to sidestep this shortcoming by changing the arithmetic weights often. In this case, however, the interpretation of the index becomes very ambiguous (Domar, 1962). Furthermore, in the limiting case of continuous change in weights, for example, by using moving weights, it turns out, surprisingly enough, that the productivity index is approximately constant through time (M. Brown, 1966, p. 98).

For those reasons, we proceeded by estimating marginal productivity directly from the production function. Two estimates of input productivities (I and II) are presented. In I, the productivities of capital and labor for four regressions (R_1, R_2, R_3, and R_4) are computed based on the actual output (Q); thus, the marginal productivity of capital, for example, is equal to the coefficient of capital times the output capital ratio. In II, the productivities of the inputs for three regressions (RE_1, RE_2, and RE_3) are computed from production function estimate of output (Q). Calculating two estimates permits comparison. Because both I and II generally give similar results, and in order to eliminate redundancy, only R_1 and R_2 (Tables 5-2 and 5-3) are analyzed. The rest of the estimates are deferred to Appendix A. For labor, the estimate has been segregated to productivity per worker per year, per man-hour of work per

TABLE 5-2

ESTIMATES OF MARGINAL PRODUCTIVITIES OF CAPITAL AND LABOR FOR EGYPT

Year	$ MPL per year	$ MPL per day	$ MPL per hour	$1,000,000 MPK
1962	746.97	2.13	.27	1.53
1963	798.51	2.24	.28	1.33
1964	835.38	2.38	.30	1.29
1965	815.42	2.32	.29	1.47
1966	822.74	2.34	.29	1.53
1967	796.40	2.27	.28	1.74
1968	779.44	2.22	.27	1.93
1969	807.83	2.30	.29	1.84
1970	838.31	2.39	.30	1.61
1971	844.23	2.41	.30	1.65
1972	847.75	2.42	.30	1.78
1973	913.75	2.60	.33	1.45
1974	969.34	2.76	.35	1.32
1975	1123.36	3.24	.40	0.94
1976	1176.08	3.35	.42	0.91
1977	1252.51	3.57	.45	0.84

Where RE_1 = log Q = 4.11 + 1.22 log L + .285 log K

TABLE 5-3

ESTIMATES OF MARGINAL PRODUCTIVITIES OF CAPITAL AND LABOR FOR EGYPT

Year	$ MPL per year	$ MPL per week	$ per day	$ per hour	$1,000,000 MPK
1962	990.70	18.01	2.80	.35	2.03
1963	1043.43	20.86	2.97	.37	1.79
1964	1082.02	21.64	3.08	.39	1.67
1965	892.26	17.98	2.60	.32	1.61
1966	910.94	18.20	2.59	.32	1.70
1967	905.99	18.10	2.58	.32	1.98
1968	912.90	18.36	2.60	.33	2.26
1969	966.51	19.33	2.75	.34	2.20
1970	1068.76	21.42	3.04	.38	2.04
1971	1104.00	22.08	3.15	.39	2.15
1972	1097.57	21.91	3.13	.39	2.31
1973	1372.18	27.44	3.92	.48	2.17
1974	1200.49	24.00	3.47	.43	1.64
1975	1247.72	24.95	3.55	.44	1.05
1976	1459.98	29.19	4.10	.52	1.14
1977	1585.40	31.71	4.50	.56	1.06

Where R_1 = log Q = -4.11 + 1.22 log L + .285 log K

MPL = 1.22 Q/L

MPK = .285 Q/K

week, per work day, and per worker per hour.

The estimates from RE_1 yield a marginal productivity per year of an Egyptian worker that ranges from \$746.97 (in 1962) to \$1252.51 in 1977, or from \$2.13 to \$3.57 per man-hour of work day. The marginal product per worker per year increased from 1962 to 1964, then declined for the following three years to \$779.44 in 1968. The decline in the marginal productivity of labor is a direct corollary to the decline in capital stock that occurred during the same period. This can be seen from Table 5-4.

TABLE 5-4
CAPITAL-LABOR RATIO OF EGYPTIAN LABOR IN \$

Year	K/L
1962	113.9
1963	136.3
1964	151.2
1965	129.4
1966	125.5
1967	107.1
1968	94.4
1969	102.8
1970	122.2
1971	116.2
1972	145.9
1973	177.2
1974	283.1
1975	315.3
1976	301.3
1977	348.1

Source: National Income Account Monthly Bulletin, published by National Bank of Egypt, 1961-1977.

The capital-labor ratio increased from \$113.9 in 1962 to \$151.2 in 1964, and then declined until it reached its lowest level, \$94.49, in 1968. This decline is consistent with the decline in the marginal

productivity of labor during the same period. The lowest level of productivity corresponds to the lowest level of capital-labor ratio, which took place in 1968. The rationale for the decline in marginal productivity is simple and straightforward: the higher the availability of capital for labor to work with, the higher the productivity of labor, and vice versa. This seems to hold true in this case.

Through the period under consideration, the marginal productivity per hour of the Egyptian worker ranged from $0.27 to $0.45. These estimates are very low in comparison to other LDC's, and in particular to labor productivity in Libya, as we will see in the following chapter. Furthermore, its rate of growth is "low" in comparison to the growth rate of capital productivity in Egypt. The results obtained for the marginal productivities of capital ranged from $1.53 per unit of capital in 1962 to $0.84 in 1977. The estimates of the marginal productivity of capital confirm our hypothesis that marginal productivity of capital is higher than MP_K for Libya, as we will see in the following chapter.

The MP_K is a pure number since "capital" is expressed by substituting capital values for physical capital. As stated earlier, due to lack of reliable data on physical capital, gross fixed capital formation has been used as a substitute. This not only facilitates the estimate of the production function, but also allows comparisons with MP_L since both estimates will be expressed in monetary value. For this reason, the estimate of MP_K should be taken to explain the general trend rather than the specific weight for each estimate. To reiterate, the approximation of capital in either

physical terms or monetary values generally does not provide the most appropriate estimate of capital inputs to use in a production function. Capital inputs must be introduced in terms of current service flows rather than in terms of capital stocks (Griliches, 1969). This means that the estimate of MP_K is a question of "more or less" rather than "yes or no," and obviously it reduces the precision of the individual regression coefficient.

We have to keep in mind that the estimate of marginal productivity depends rather critically on the elasticities of output with respect to input, on factor proportions, on the proper measurement of input and output, and on the weighting scheme used for their aggregation. Then, if we look at the results yielded by R_1, we find that although they are higher than RE_1 they tend to confirm the conclusions that were based on the analysis of RE_1. In general, the Egyptian MP_L is "low" relative to MP_L in other LDC's and also relative to the marginal productivity of Libyan labor. The marginal productivity per man-hour of work in Libya increased from \$0.35 in 1966 to \$0.56 in 1977. Labor productivity follows the same pattern of RE_1, where it increases, then declines (corresponding to the decline in capital-output ratio), then increases again. The estimate obtained for the marginal productivity of labor is "high" relative to MP_K of Libya and relative to other estimates of LDC's (M. Gollas, 1970, p. 80). R_3 and R_4 give the same results, more or less. Finally, R_1 and R_2 give the most desired estimates for the simple reason that they are obtained from the regressions that give the most significant coefficient.

D. Factor Intensity in Egypt

Factor intensity may change as a result of change in factor prices. In order to distinguish sharply those changes in factor proportions that have a purely technological origin from those induced by relative factor price changes, we will assume for the moment that the relative prices of capital and labor remain constant. This feature can be determined empirically in terms of the marginal rate of substitution of two factors (MRS). MRS is defined as the ratio of the respective marginal product,

$$r_{kl} = \frac{\partial Q/\partial L}{\partial Q/\partial K} ,$$

in the case of the CD production function,

$$r_{kl} = \frac{\alpha K}{\beta L} , \qquad 5.14$$

where β, α are the elasticities for production of K and L, respectively.

The estimates of the marginal rate of substitution are shown in Table 5-5. Using an isoquant map, it can be easily shown that two different points corresponding to different levels of output with the same price ratio will have the same MRS (Yotopoulos, p. 145). Therefore, the coefficient of capital must be higher for the larger output and, correspondingly, the coefficient of labor must be lower. This also appears from equation 5.14. For a given r, K/L varies inversely with α/β. However, since the CD function α and β are both constant by hypothesis, the technology with the lower α/β will have the higher K/L and is thus the more capital-

TABLE 5-5

ESTIMATES OF MRS K FOR L IN $

Year	R_1	R_2	R_3	R_4
1962	487.6	216.0	811.6	399.6
1963	583.6	258.5	971.1	479.05
1964	647.0	286.7	1076.9	530.3
1965	553.8	245.4	921.7	453.8
1966	537.4	238.1	894.4	383.8
1967	458.5	203.2	763.2	375.8
1968	404.5	179.2	673.2	331.5
1969	439.9	194.9	732.1	360.5
1970	523.0	231.8	870.5	428.6
1971	499.9	221.5	832.0	409.7
1972	624.6	276.7	1039.5	511.9
1973	758.3	332.1	1262.0	621.4
1974	1211.9	538.3	2021.9	995.6
1975	1349.4	597.9	2245.9	1105.9
1976	1289.7	571.5	2146.5	1056.9
1977	1490.0	660.2	2479.9	1221.1

intensive technology.

Table 5-5 shows the results of MRS of K for L for separate regressions. Although the results vary from one regression to the other, depending on the coefficients of capital and labor, the pattern of substitution between capital and labor is the same in all four estimates. For R_1, it required \$487.60 units of capital to replace one Egyptian worker in 1962. The amount of capital required to substitute one worker increased slightly during the next four years, then declined slightly until 1969. The decline in MRS was consistent with the decline in the capital stock that occurred during the same period. The marginal rate of technical substitution increased after 1969, reaching \$1490 in 1977. The increase in MRS again corresponded to the increase in the capital-labor ratio for the same period. The other estimates of MRS of K for L conform to the same behavior.

The increase of MRS is not inconsistent with the notion that the Egyptian economy as a whole is labor intensive, because MRS will decline if we are observing one isoquant. However, this does not have to be the case when the comparison is between different levels of output. The MRS of K for L declines along each isoquant (see Appendix B). The factor prices did remain unchanged; furthermore, wage levels have been increasing at a low but steady rate. Nevertheless, even in a labor abundant economy, this could mean that more capital would have to be given up if one unit of labor became available. The question of how high Egypt's MRS will become is clearer when we compare it with Libya's and see

that the rate at which capital is substituted for labor is much higher. Finally, the changes in the relative ratio of capital to labor depend on the product of two terms, the elasticity of substitution, σ, and the changes in the MRS. Next we will consider the elasticity of substitution.

E. The Elasticity of Substitution

The translog production function helps determine the value of the elasticity of substitution between capital and labor for the Egyptian economy, as reflected in the sample data. This determination is crucial if the economic hypothesis regarding labor abundance is to be tested.

Estimation of AES between Egyptian Capital and Labor

This stage of the estimation procedure establishes the starting points for the parameter which will be estimated using IZEF estimation in the second stage. The distribution share equations are:

capital share $$S_1 = a_1 + b_{11}\ln X_1 + b_{12}X_2, \qquad 5.15$$

labor share $$S_2 = a_2 + b_{12}\ln X_2 + b_{22}X_2. \qquad 5.16$$

Divided by X_2:

$$S_1 = a_1 + b_{11}\ln(X_1/X_2) \qquad 5.17$$

Using the linear homogeneous restriction, the remaining parameters are:

1) $a_1 + a_2 = 1$

2) $b_{21} = -b_{11}$

3) $b_{12} + b_{22} = 0$

The second stage

In the second stage, the system of the share equations in Case I is estimated. The numerical values obtained from estimating (5.17) are the starting points for the respective parameters. The results are:

$$\overset{*}{S}_1 = .485 + .0952 \ln\overset{*}{X}_1 - \underset{(.0318)}{.0952} \ln\overset{*}{X}_2; \qquad 5.18$$

$$\overset{*}{S}_2 = .515 - .09522\ln X_1 + .09524 \ln X_2. \qquad 5.19$$

Both coefficients are significant at a confidence level of 95 percent. Using the estimated parameters together with estimates of the remaining parameters [implied by the restrictions $b_{ij} = b_{ij}$ $(i \neq j)$] and constant returns to scale, we compute the elements of $|\overset{*}{F}|$ and calculate $|\overset{*}{F}_{12}|$. Using (2.20), the Allen partial elasticity of substitution between capital and labor is estimated to be 1.79.

For the purpose of checking the monotonicity condition and the concavity condition, the distributive share values at sample mean and the Hessian matrix of partial second derivative are evaluated as follows. First, the results indicate that the estimated parameters have significant t statistics at the 5 percent level of significance. Second, the distributive share values evaluated at sample means of capital and labor exhibit positive signs:

$S_k = .408 > 0;$

$S_l = .592 > 0.$

Therefore, the monotonicity condition is satisfied. The Hessian matrix of partial second derivatives,

$$|H^*| = \begin{vmatrix} f_{11} & f_{12} \\ f_{21} & f_{22} \end{vmatrix} = \begin{vmatrix} -.000183 & .00010 \\ .00010 & -.000016 \end{vmatrix}$$

$$= -.000000008$$

shows that H exhibits the semi-definite sign ($|\bar{H}^*|<0$); that is, $\bar{H} = -.000000008<0$, or virtual zero value. This indicates that the concavity condition is also satisfied. The satisfaction of both conditions suggests that, in general, the aggregate production function for the Egyptian economy is well behaved according to economic theory.

Third, the Allen elasticity of substitution between capital and labor, $\sigma_{KL} = 1.79$, is positive, which indicates that the relationship between capital and labor is that of substitution (with two factors it is always positive). The implication is that an increase in the price of capital of one percent will increase the amount of labor in the production process.

The value of AES declined between 1962 and 1977, as shown in Table 5-6. The small decline can be attributed to the "small" increase in the capital-labor ratio that occurred during the same period, which in turn was reflected in the labor share decline from 0.723 to 0.617 and the increase in the capital share from 0.277 to 0.383.

TABLE 5-6

ESTIMATES OF THE AES FOR THE EGYPTIAN ECONOMY

Year	AES of capital of labor σ	Distributive Shares S_K	S_L
1962	1.91	.2773	.7227
Mean value	1.79	.3127	.6873
1977	1.67	.3836	.6164

Using the translog production function to test for technological change, the formulation is as follows:

$$S_K = a_1 + a_2T + b_{11}\log(X_1/X_2) + b_{12}\, T\, \log(X_1/X_2) \qquad 5.20$$

The estimate of equation 5.20 is:

$$S_K = .368 + .025T + .104\log(X_1/X_2) + .00001\log(X_1X_2) \qquad 5.21$$

with log likelihood function equal to 212.7. When the restriction that a_2 and b_{12} are equal to zero is imposed, the log of likelihood function is equal to 200.8. The formula for testing the hypothesis that $a_2 = b_{12} = 0$ is:

$$\frac{\text{The log of likelihood for the restricted function}}{\text{The log of likelihood for the unrestricted function}} =$$

$$-2 \log \lambda \sim \chi^2_2 \qquad 5.22$$

where 2 is the number of the restrictions. The computed value of chi square is equal to 11.9. At 95 percent of confidence, the table value of chi square with two degrees of freedom is equal to 7.378. Based on this, the hypothesis that $a_2 = b_{12} = 0$ is rejected; that is,

technological changes have not been neutral during the period from 1962 to 1977.

AES and income shares

The value of elasticity has important empirical implications not only with respect to the substitutability between factors of production, but also with respect to income distribution. An elasticity of substitution equal to one implies that factor shares will remain constant even if capital substitutes for labor over time as a result of changes in the factor intensity of technology and/or of changes in relative factor prices.

The elasticity of substitution of the Egyptian economy has been estimated at 1.79. This implies that the share of the factor whose price has risen (and therefore whose quantity has fallen) will decline. This has an important implication for the economy as a whole. First, as the wage rate increases, we would expect the share of labor to decline. Second, as the available empirical evidence suggests (Appendix C), the elasticity of substitution in industry is generally less than one, while in agriculture it is more than one. Based on this, it is safe to assume that the elasticity of substitution of the agricultural sector in Egypt is more than one. We would then expect that as the wage rate increases, the share of agricultural labor would decline. The result of technological change would be to shift the distribution of labor income from agriculture to manufacturing. However, this shift cannot be achieved easily in Egypt because of the constraints on the industrial sector mentioned earlier, of which the most important is the shortage of

capital.

The rationale behind the relationship between σ and factor share is clear. The parameter σ reflects the facility with which factors can be substituted for each other. If it is relatively easy to do so, the factor whose price has increased will be substituted for; but if substitution is not easy, then the share of the factor whose price rose will increase.

F. Policy Implication of Resource Allocation

Allocation of resources to and from Egypt will have two distinct effects through altering factor prices and/or factor supply. This may lead to several changes: (1) in quantity and price of the allocated resource; (2) in prices and quality of other factors which are substitutes or complements; (3) in factors shares; and (4) in the productivity of labor and/or capital. We will evaluate these effects under three scenarios. In the first, we assume that only labor is to be transferred from Egypt to Libya. In the second, we assume that only capital is to be transferred from Libya to Egypt. In the third, we assume that labor is transferred from, and capital is transferred to, Egypt.

1. The first scenario

The transfer of labor from Egypt to Libya (a reduction in the total labor force) will result in higher prices of labor, the rise depending on the number of workers transferred. Obviously, the larger the number, the higher the rate of increase will be. However, because of the labor surplus, the rate of increase will tend

to be moderate.

Higher labor prices will affect the amount of capital in the production process. Because capital and labor are substitutes and $\sigma>1$, we can expect capital to be substituted for labor. The scale of substitution will tend to be low, due to the moderate increase in the price of labor and the acute shortage of capital.

The decline in the labor force and the moderate rise in its prices will probably lead to a significant decline in the labor share. Meanwhile, the share of capital will increase. This reflects the fact that there are no significant changes in the relative prices of capital and labor in response to the major change in the capital-labor ratio. Finally, we can expect that the allocation of labor to Libya will result in higher productivity for the Egyptian labor force for the simple fact that capital per worker will increase.

2. The second scenario

Capital transfer to Egypt (without labor transfer in the opposite direction), which means an increase in the capital stock, will lead to lower prices of capital. Again, the price decrease will depend on how much capital is transferred. The low price will increase the amount of capital in the production process through the substitution of capital for labor. Recall that when $\sigma>1$, this implies that the share of the factor whose price has risen (declined) will decline (increase). Thus, lower prices of Egyptian capital mean that the share of capital will increase. Finally, transfer of capital will result in increased labor productivity, probably modest relative to the gain which would occur under the first scenario. This is because

capital transfer is likely to take the form of assets, at least partially. The time lag involved in the transformation of these assets to physical capital will make the gain in productivity, at least for the immediate time, modest.

3. The third scenario

A reduction in the total labor force due to labor transfer will result in a higher price of labor, as mentioned before. Because of the ease of substitution, capital will be substituted for labor, which will be manifested in the decline in the labor share. This decline will be enforced by capital transfer to Egypt, where the lower prices of capital will initiate further substitution of capital for labor, thus leading to further decline in the labor share and a concomitant rise in capital share. Notice that the effect of allocating labor and capital from and to Egypt will work in the same direction of increasing the capital and decreasing the labor share. Here again, the increase in the price of labor will most likely be modest since the labor transfer effect will be at least partially mitigated by the labor surplus, which indicates that the overall decline in labor share will most likely be smaller than would be anticipated. Finally, the effect on labor productivity will most likely be significant, due primarily to the sharp increase in the capital-labor ratio.

G. Allocative Efficiency

An intuitive notion of efficiency refers to the achievement of maximum output from a given set of resources. The greater the output

relative to the inputs, the higher is the level of efficiency. The significance of examining efficiency in the Egyptian economy relates to the objective of allocating resources, that is, bidding the resources away from alternative uses. As a result of such resource transfers, aggregate output may be increased or decreased. The estimated elasticities of production indicate changes that take place in the value of output when we change the level of a given input. Would these changes increase efficient use of the factors of production? In order to answer this question, an index of efficiency must be found. It can be obtained through allocative efficiency.

The traditional test for allocative efficiency (T.W. Schultz, 1960) is based on the assumption that all sectors in the economy use the same technology and that they face the same prices. It is further assumed that if the efficiency conditions exist in all sectors, the economy is Pareto optimal. If disequilibrium exists in the agricultural sector, then a correction through a decrease or an increase in the use of the factors may lead (but not necessarily) to Pareto optimality. The efficiency index is obtained by comparing the marginal product of a given resource to its opportunity cost.

Maximum efficiency occurs when the value of the marginal product of a resource is equal to the unit cost of that resource. If the ratio of marginal product to opportunity cost is more than one, too little of that resource is being used at a given price level. If the ratio is less than one, then too much of that resource is being used.

The estimate for marginal productivities is obtained from the production function. It is important to use those estimates (rather than the productivity index, for example) because within the context of the production function, the uniqueness of the isoquant is guaranteed when it depicts the minimal combinations of inputs that can produce the unit of output. Alternatively, the isoquant shows the maximum quantity of output that can be produced with any combinations of inputs.

As a measure of the opportunity cost of one unit of labor, we took the average wage per worker per year (as shown in Table 5-7). The index then is compiled by using the marginal productivity of labor from R_1. The estimate in Table 5-8 indicates inefficient use of labor in both the distribution sector and the service sector. The commodity sector, in contrast, displays a ratio of more than one, which indicates that "not enough" labor has been employed in that sector. This conclusion, however, needs to be qualified.

The commodity sector combines agriculture, manufacturing, construction, and electricity. Productivity per worker in the latter three is much higher than in agriculture. For example, productivity per worker in manufacturing averages about ten times higher than productivity per worker in agriculture (Table 5-9). This implies that manufacturing is more efficient, which is consistent with the overall efficiency index obtained for the commodity sector. In comparison, agricultural productivity indicates a very low level of efficiency. Furthermore, if we take into account the fact that agriculture is the largest single employer in the economy,

TABLE 5-7.

AVERAGE WAGE IN THREE MAJOR SECTORS
($)

Year	Commodity Sectors	Distribution Sectors	Services Sectors
1962	127.6	322.0	461.4
1963	148.5	331.2	499.1
1964	159.6	356.5	544.4
1965	174.1	374.9	460.5
1966	187.2	391.2	483.0
1967	192.1	392.0	488.7
1968	188.6	403.6	472.1
1969	196.2	414.0	495.0
1970	201.9	423.0	519.8
1971	235.9	444.8	687.7
1972	240.8	460.3	720.4
	$\overline{W}_c$ = 186.6	$\overline{W}_d$ = 391.12	$\overline{W}_s$ = 530.18
	T = 2052.51	4313.3	5832.0

Source: National Bank of Egypt Bulletin, December 1976.

TABLE 5-8.

EFFICIENCY INDEX OF THE THREE MAJOR SECTORS
($)

Year	Commodity Sectors	Distribution Sectors	Service Sectors
1962	1.90	.79	.55
1963	1.83	.82	.54
1964	1.70	.80	.52
1965	1.60	.74	.60
1966	1.50	.71	.58
1967	1.40	.69	.55
1968	1.20	.56	.48
1969	1.40	.66	.55
1970	1.42	.67	.55
1971	1.20	.65	.42
1972	1.30	.63	.40

TABLE 5-9.

EMPLOYMENT AND PRODUCTIVITY IN AGRICULTURE AND MANUFACTURE
($)

	Agriculture		Manufacturing	
Year	Employment	Annual Average Productivity	Employment	Annual Average Productivity
1962	3,600.0	238.3	679.0	1049.9
1963	3,632.0	269.3	725.9	1111.82
1964	3,730.0	297.4	789.7	1142.6
1965	3,751.0	256.96	825.0	1152.8
1966	3,877.2	359.26	841.7	1259.9
1967	3,864.6	364.3	846.7	1296.74
1968	3,892.4	380.9	367.3	1219.0
1969	3,964.9	399.3	890.7	1301.1
1970	4,048.3	438.16	916.1	1360.7
1971	4,056.9	438.84	1052.8	1335.2
1972	4,094.7	586.9	1094.3	1337.9

Source: National Bank of Egypt Bulletin, 1976, p. 130.

it can be seen how inefficiency is widespread. This implies that the efficiency index obtained for the commodity sector is a rather inaccurate parameter for the actual efficiency of the sector. Finally, if we compare the marginal productivity estimated at the geometric mean with the average mean of the three sectors, the ratio is \$0.76 (282.2/3696). This can be taken as a general indication of inefficiency that calls for labor reallocation.

H. Optimum Level of Egyptian Labor

According to the marginal productivity theory, the marginal product of labor is equal to the wage rate. In a CD model, for example, we have

$$\overline{W}_1 = \alpha \frac{Q}{L} \qquad 5.23$$

where $\overline{W}_1$ is an "average" wage rate, Q is output, L is quantity of labor, and α is the labor coefficient in the production function. Given an estimate of α, we can solve for L in terms of α, Q, and $\overline{W}_1$. This would give us the quantity of labor that equates the marginal product to the wage rate. By comparing this estimate with the quantity of labor actually used, we can measure the extent of surplus labor.

For the sample as a whole, the estimated level of labor output at which the marginal productivity of labor equals the postulated opportunity cost of \$396.60 per year is 6,227,579 workers for R_1, which indicates a labor surplus of 1,928,300 workers, as can be seen from Table 5-10. For R_4 at the same average wage rate of

TABLE 5-10.
ESTIMATE OF THE LABOR SURPLUS IN THE EGYPTIAN ECONOMY

	R_1	R_4
Labor (man-year)	6,227,579	1,168,318
Surplus	1,928,300	6,987,800

all sectors, the estimate level of labor is only 1,686,318, which indicates a much larger labor surplus.

This rather unrealistic result of the optimum level of labor points out the limitations of this kind of analysis. The optimum levels of labor estimated in R_1 and R_4 are sensitive to changes in the opportunity cost of labor and particularly to the size of the labor coefficient. For example, an increase in the annual average wage rate of $300 will reduce the optimum level of labor by about half a million workers. A reduction in the labor coefficient of about 10 percent (from 1.22 to 1.08) in R_1 reduces the optimum level of labor by about 74 percent (from 6,287.2 to 1,562.0).

The extreme sensitivity of equation 5.23 to variation in the size of the production elasticity coefficients imposes serious limitations on its use. However, it is important to observe that although the estimated levels of Egyptian labor vary widely, all estimates indicate a surplus of labor. The unsettled question is the size of that surplus.

I. Summary

The various measurements of the aggregate production function for the Egyptian economy revealed the labor-intensive nature of the economy as a whole. This conclusion was supported by the factor intensity analysis of capital and labor. Those estimates provided a starting point for productivity measurement of inputs. Although the measurements varied depending on the labor coefficient for each equation, they yielded the same trend of both labor and capital over time.

The productivity of labor increases, then decreases, and then increases again. This behavior is consistent with the increase and decline in the capital stock. The productivity estimates tend to confirm the hypothesis of low productivity of Egyptian labor relative to other LDC's and, in particular, to the productivity of Libyan labor, as will become apparent in the following chapter. The productivity of capital is somewhat higher than that of labor. Yet, the results are inconclusive when testing for the hypothesis that the rate of growth of capital productivity is higher than that of labor.

The estimate of the elasticity of substitution between capital and labor indicates that it is "easy" to substitute capital for labor. However, the isoquants tend to be "flatter" than expected. The estimate was used to evaluate the impact of allocation of resources under three different scenarios. The analysis seems to suggest that the transfer of labor to Libya coupled with capital transfer in the opposite direction will lead to an increase in the

in the productivity of labor. The enhancement will be due primarily to the sharp increase in the capital-labor ratio. Furthermore, the share of capital will increase and the share of labor will most likely decrease as a result of the reallocation of resources.

Finally, the analysis of allocative efficiency and the optimal level of resources shows strong evidence of inefficiency, particularly in the allocation of the labor force. Thus, the reallocation will most likely increase efficiency of resources, in particular labor.

Chapter 6

Model Estimation for Libya

A. Introduction

This chapter presents the results of estimates of the CD production with two inputs, labor and capital. The translog production function estimates are also presented. The prevailing production technology is assumed to be the same across Libya.

The hypotheses that need to be tested are: first, that the productivity of Libyan labor is high relative to that of Egyptian labor; and second, that the reallocation of resources to and from Libya should increase the overall productivity of both capital and labor.

Among the results that will be discussed are: (1) estimates of CD production function for Libya; (2) human capital; (3) productivity measurement for Libya; (4) factor intensity; (5) elasticity of substitution between capital and labor; and (6) policy implications.

B. Estimates of CD Production Function

A CD production function is fitted for the Libyan economy with data covering the period 1962-1977. The independent variables are labor and capital. The dependent variable is gross domestic product. The results are:

$$\log Q_t = \underset{(-1.26)}{-3.8} + \underset{(1.6)}{1.17} \log L + \underset{(3.2)}{.71} \log K \qquad \bar{R}^2 = .97 \qquad 6.1$$

The coefficient of capital is significant at the 5 percent significance level. It shows that a one percent increase in capital will lead to a 0.7 percent increase in output. The coefficient of labor, however, is not significant.

The assumption of no technological changes (embodied in equation 6.1) was abandoned, and the equation was estimated with time as an additional independent variable, T. The estimated result is:

$$\log Q_t = \underset{(2.89)}{12.1} - \underset{(-1.98)}{1.58} \log L + \underset{(4.09)}{.59} \log K + \underset{(4.3)}{.21} \log T \qquad 6.2$$

$$\bar{R}^2 = .99$$

Although the variable T is significant, which could imply that technological changes have not been neutral during 1962-1977, the labor coefficient not only is insignificant, but also carries the wrong sign. Equation 6.2 has a Durbin-Watson test of 1.65. This can indicate the existence of autocorrelation. Adjusting for this, the estimate is:

$$\log Q_t = \underset{(2.7)}{11.9} - \underset{(2.6)}{1.56} \log L + \underset{(1.2)}{.57} \log K + \underset{(3.9)}{.21} \log T \qquad 6.3$$

$$\bar{R}^2 = .98$$

As can be seen from equation 6.3, labor still has the wrong sign. When the variable T is dropped from equation 6.3, the results are more satisfactory:

$$\log Q_t = \underset{(-2.28)}{-7.3} + \underset{(2.7)}{1.99} \log L + \underset{(2.3)}{.48} \log K \quad \bar{R}^2 = .91 \qquad 6.4$$

$$DW = 2.1$$

Both coefficients are significant. Equation 6.4 shows that a one

percent increase in labor or capital will increase output by 1.99 or .48 percent, respectively. Notice that whenever the time trend is added to the equation, the labor coefficient becomes negative. A possible explanation is that technological change is embodied in the labor input. This possibility will be tested later.

When the production function is restricted to pass through the origin, the estimated equation is:

$$\log Q_t = \underset{(3.2)}{.25} \log L + \underset{(14.0)}{.97} \log K \qquad 6.5$$

Both labor and capital coefficients are highly significant when compared with equation 5.3. The difference between the two production functions becomes very apparent. For Egypt, the elasticity of output with respect to labor is .698, or three times that of Libya. Conversely, the elasticity of output with respect to capital is only about one-third that of Libya. Those estimates of the coefficient reflect accurately the factor endowment of each country.

An alternative formulation of the production function is to lag the adjusted gross capital formation one year and re-estimate the equation. The results are:

$$\log Q_t = \underset{(2.0)}{-5.4} + \underset{(2.6)}{1.72} \log L + \underset{(2.4)}{.48} \log K_{t-1} \qquad \bar{R}^2 = .97 \qquad 6.6$$

$$DW = 1.36$$

The results represent a good fit. When equation 6.6 is adjusted for autocorrelation, the results are:

$$\log Q_t = \underset{(-2.1)}{6.59} + \underset{(2.6)}{1.98} \log L + \underset{(1.8)}{.41} \log K_{t-1} \qquad \bar{R}^2 = .94 \qquad 6.7$$

The previous estimates of the production function for Libya show first, that the Libyan economy is labor intensive. This may appear strange, but not when we realize that "financial capital" abundance does not translate immediately to productive capital; that is, flow of services. The fact that Libya has to import all its capital goods introduces a time lag. More important, the shortage of skilled and unskilled labor imposes the major restriction on domestic capacity and prevents the absorption of surplus capital. Second, the Libyan economy has been experiencing increasing returns to scale during the period, which is probably due mainly to the oil sector.

Returning to the concept of technological changes, the inference from equation 6.2 that such changes have been non-neutral is not a comfortable one because the equation does not represent a good fit overall. If, instead, we want to test the hypothesis that technological change is embodied, that is, introduced in the variable itself, this can be accomplished by redefining the units in which the inputs are measured. Similar to equations 5.8 and 5.10, equations 6.8 and 6.9 represent the estimates of the production function. Augmented capital is the dependent variable in 6.8, and both augmented capital and labor are the dependent variables in 6.9. The estimates are:

$$\begin{array}{lll} \text{Log } Q = 5.6 - \underset{(0.46)}{0.43}\log L + \underset{(0.20)}{0.58}\log K - \underset{(3.94)}{0.000004}\log KU + \underset{(0.56)}{.15}T + \underset{(1.42)}{} & & 6.8 \\ \bar{R}^2 = .98 & & \\ \log Q = 0.98 + \underset{(0.76)}{0.61}\log L + \underset{(0.25)}{0.33}\log K + \underset{(1.18)}{.000002}\log Ku - & & \\ \underset{(1.07)}{.00003}\log Lu + \underset{(1.07)}{.27}T \qquad \bar{R}^2 = .97 & & 6.9 \end{array}$$

where Ku and Lu are augmented capital and labor, respectively. The coefficients of factor augmentation are small (not different from zero) and not significant. This can be interpreted as a rejection of the hypothesis that technological changes are labor or capital augmented. As we will see later in this chapter, both the ratio of marginal productivity of capital and labor and their respective shares change over time, which--as in the case of Egypt--reinforces the notion that technology has been non-neutral throughout the period under consideration.

C. Human Capital

To account for the change in productivity due to the change in labor quality, an attempt was made to incorporate "human capital" in the production function. The International Labor Organization (ILO) classification of the labor force by occupation was used to segregate labor into three major categories. Unskilled labor (LU) is composed of production-related workers, transport equipment operators, laborers, and workers not classifiable by occupation. Agricultural workers (LA) include foresters, fishermen, and hunters. Skilled labor (LS) is composed of professional and technical, managerial and administrative, clerical, sales, and service workers.

Agricultural workers are in a separate category because agriculture absorbs more than 50 percent of the labor force. Thus it was thought that the distinction would be significant in identifying the contribution and, more important, assist in the measurement of labor redundance in that sector.

The results obtained were mixed and generally unsatisfactory. Below is a sample of the different formulations that have been estimated:

$$\log Q_t = \underset{}{11.07} - \underset{(.72)}{.138}\log K + \underset{(.06)}{.08}\,LU + \underset{(1.8)}{2.21}\log LS - \underset{(3.8)}{2.25}\log LA; \quad 6.10$$

$$\log Q_t = \underset{}{9.9} - \underset{(.52)}{.08}\log K - \underset{(.52)}{.12}LU + \underset{(1.60)}{1.26}\log LS - \underset{(1.7)}{1.13}\log LA +$$

$$\underset{(2.4)}{.028}\log T; \quad 6.11$$

$$\log Q_t = \underset{}{13.4} - \underset{(5.2)}{.43}\log K + \underset{(.08)}{.062}\log LU + \underset{(1.2)}{2.8}\log LS + \underset{(12.6)}{2.8}\log LA. \quad 6.12$$

Based on these estimates, human capital as such will not appear in the production function.

D. Productivity Measurement for Libya

As was the case with Egypt, two estimates of input productivity (I and II) were calculated for Libya using the same procedure. The results of R_1, R_2, RE_1, and RE_2 are presented in Tables 6-1 and 6-2. The rest of the estimates are deferred to Appendix A.

The estimates for marginal productivities of both labor and capital obtained from R_1 are similar to those obtained from R_4. Estimates from R_2 are much lower, due primarily to the lower labor coefficients. Although the estimates differ, they yield the same productivity trends for both labor and capital. Those trends are, first, that in all four estimates the productivity of labor increased steadily except for a short period (1964-1970) that corresponded to the decline in the capital-labor ratio. Second, the marginal pro-

TABLE 6-1.

ESTIMATES OF MARGINAL PRODUCTIVITY OF CAPITAL AND LABOR FOR LIBYA

Year	$ MPL per year	$ MPL per day	$ MPL per hour	$1,000,000 MPK
1962	1251.22	3.56	.45	.55
1963	1391.79	3.97	.50	.56
1964	1734.63	4.94	.61	.50
1965	2189.25	6.24	.78	.44
1966	2564.54	7.31	.91	.43
1967	2812.42	8.01	1.00	.44
1968	3380.48	9.63	1.20	.41
1969	3665.30	10.44	1.30	.43
1970	3159.80	9.00	1.13	.58
1971	3705.75	10.56	1.32	.56
1972	4877.41	13.89	1.74	.48
1973	6634.09	18.90	2.36	.44
1974	8794.61	25.06	3.13	.44
1975	10204.60	29.07	3.60	.49
1976	10661.17	30.37	3.80	.53
1977	12006.65	34.21	4.28	.52

$Q = 3.8 + 1.72 \log L + .48 \log K$

TABLE 6-2.

ESTIMATES OF MARGINAL PRODUCTIVITIES OF CAPITAL AND LABOR FOR LIBYA

Year	MPL per year	MPL per week	Per day	Per hour	MPK
1962	2915.37	58.31	8.30	1.03	1.28
1963	4065.45	81.31	11.58	1.45	1.64
1964	5864.23	117.28	16.71	2.09	1.69
1965	8040.78	160.81	22.91	2.86	1.63
1966	9830.39	196.61	28.00	3.50	1.64
1967	11013.67	220.27	31.38	3.92	1.73
1968	14730.14	294.60	41.97	5.24	1.80
1969	15942.27	318.84	45.42	5.68	1.86
1970	15816.48	316.33	45.06	5.63	1.91
1971	16984.53	339.69	48.39	6.05	2.57
1972	19267.17	385.34	54.89	6.86	1.92
1973	24003.95	480.08	68.39	8.55	1.61
1974	38021.00	760.42	108.32	13.54	1.91
1975	32439.69	648.79	92.42	11.55	1.57
1976	40109.22	802.18	114.27	14.28	2.00
1977	44764.24	895.29	127.53	15.94	1.97

$\log Q = 3.8 + 1.72 \log L + .48 \log K$

$R_1 = MPL = 1.72 \frac{Q}{L}$

$MPK = .48 \frac{Q}{K}$

ductivity of capital increased over time, but its behavior was erratic, probably for the same reasons that explain the pattern of behavior of marginal productivity of Egyptian capital. Third, all four estimates tended to confirm the original hypothesis, that is that marginal productivity of Libyan labor is higher than the marginal productivity of Egyptian labor.

The estimates from RE_1 yield an annual marginal product of labor ranging from \$1251.22 in 1962 to \$12006.65 in 1977, or from \$3.56 to \$34.21 per man-hour per workday. The marginal product per worker per year increased from 1962 to 1969, then declined for the next two years. The decline can be traced to the decline in the capital-labor ratio during the same years (as can be seen in Table 6-3). Except for two years, the capital-labor ratio grew at an annual rate of 15 percent over the period 1962-1977. This was the case with Egypt, where the decline in the capital-labor ratio was also consistent with the marginal productivity of labor.

The marginal productivity of Libyan labor per hour ranges from \$.45 to \$4.28. The estimates are much higher than those for Egyptian labor. This confirms the hypothesis regarding the productivity of labor in both countries, that is that the productivity of Libyan labor is higher than that of Egypt. The main reason for the difference in productivity is the abundance of capital that labor in Libya can work with. This can be seen directly from Table 6-3. Actually, labor productivity in Libya is higher than most estimates available for LDC's and most of the DC's. The "inflated" estimates are mainly due to the oil sector and its unique position in the economy.

TABLE 6-3.

CAPITAL-LABOR RATIO IN THE LIBYAN ECONOMY
$

Year	K/L
1962	663.2
1963	692.9
1964	966.8
1965	1374.1
1966	1676.0
1967	1778.3
1968	2284.3
1969	2386.2
1970	1518.8
1971	1845.5
1972	2806.6
1973	4168.5
1974	5549.9
1975	5761.4
1976	5587.7
1977	6336.7

Source: Computed from The Yearly Book of Statistics, United Nations, 1978, pp. 222-223.

Due to its capital-intensive nature, the oil industry has never employed directly more than 2 percent of the labor force, yet it contributes more than 60 percent of GNP. While this may not be a particularly unfortunate characteristic, since unemployment is not a pressing problem in Libya, it certainly contributes to the misleading conclusion that can be drawn from the earlier estimates. Until recently, the industry was owned and operated by foreign interests employing foreign capital and remitting abroad about 20 percent of the country's GDP (El-Jehaimi,p. 84). Furthermore, the oil produced is consumed, for the most part, in foreign markets, which means that the crude oil flows from the field to these markets and has little impact on the national economy.

Under such circumstances, oil is a "cheap" resource for Libya. That is to say, oil production as such places little pressure on the domestic supplies of scarce resources, including labor. Since oil production does not compete for local factors of production, the opportunity cost involved is virtually zero. Thus, when productivity is estimated based on the output of that sector, it is not surprising that it is so high. This can be seen from Table 6-4, in which estimates of productivity are presented for three sectors: agriculture, industry, and oil. In comparison to agriculture, which is more endogenous, labor productivity in the oil sector averages one hundred times higher than in agriculture. The implication is that aggregate estimates inflate labor productivity because of the oil sector.

The marginal productivity of capital per million units for

TABLE 6-4.

ESTIMATES OF LABOR PRODUCTIVITIES PER MAN WORKDAY
IN THREE SECTORS
($1000)

Year	Agriculture	Manufacturing	Oil
1962	.275	.930	7.057
1963	.275	.922	13.536
1964	.270	.949	21.254
1965	.374	.981	25.943
1966	.357	1.010	29.471
1967	.379	1.027	29.225
1968	.363	1.206	41.513
1969	.362	1.191	51.217
1970	.264	1.993	55.774
1971	.303	1.134	47.581
1972	.378	1.529	41.407
1973	.491	1.593	32.305
1974	.521	1.547	21.662
1975	.771	1.398	16.931

RE_1 ranged from \$0.55 in 1962 to \$0.52 in 1977. As can be seen, capital productivity increased only slightly throughout the period. This can be explained at least partially by decreasing returns, that is, successive additions of capital applied to a small population eventually will yield a diminishing marginal contribution. Another reason is that most of the investment went to the industrial and agricultural infrastructure and was not immediately transferred into industrial goods or other output. Domestically produced goods continued to be only a small percentage compared to imports. For example, in 1972 the entire output of the industrial sector was barely 10 percent of the country's \$845 million imports. Finally, as expected, the marginal productivity of capital in Egypt seems to be higher than in Libya.

The previous analysis suggests that allocation of capital from Libya to Egypt will not decrease the productivity of capital. On the contrary, all indications are that its productivity will increase, especially if matched by labor transfer in the opposite direction.

E. Factor Intensity

Measurement of factor intensity can be accomplished through estimating the marginal rate of substitution (MRS) of the two factors. Using equation 5.10, or the ratio of the respective marginal product, Table 6-5 provides estimates of MRS between capital and labor for the four regressions.

Estimates of MRS of capital for labor range from \$2277.60 in

TABLE 6-5.

MRS OF CAPITAL FOR LABOR-ESTIMATES
IN $

Year	R_1	R_2	R_3	R_4
1962	2277.60	163.60	1060.49	2635.16
1963	2478.90	178.52	1157.09	2868.07
1964	3469.96	249.23	1614.99	4014.66
1965	4932.99	354.16	2298.15	5707.35
1966	5995.14	431.67	2391.35	6935.08
1967	6366.28	458.69	2972.96	7365.64
1968	8183.40	588.19	3824.39	9468.02
1969	8571.11	614.64	3986.93	9916.47
1970	8280.88	391.64	2537.47	6288.42
1971	6608.77	475.66	3080.91	7646.19
1972	10034.98	723.64	4697.55	11610.24
1973	14909.27	1073.52	6948.20	17249.70
1974	19906.28	1431.69	9269.94	20653.50
1975	20662.22	1482.73	9636.04	16186.55
1976	20054.60	1439.46	9343.70	23202.70
1977	22722.97	1634.78	10572.95	26289.90

1962 to \$22722.97 in 1977 for R_1. This indicates that in 1977, for example, it took \$22722.97 to replace one worker. R_4 gives a similar result, while R_3 and R_4 give lower rates for the substitution between capital and labor. In all cases, the MRS_{kl} is a large positive number, indicating that a great deal of capital can be given up if one more unit of labor becomes available. This demonstrates the capital-intensive nature of the Libyan economy. In contrast, for the Egyptian economy, as we have seen, where much labor is already being used, the MRS was low, signifying that only a small amount of capital can be traded for an additional unit of labor.

The MRS of capital for Libya increased over time except for two years. The decline was caused by the decline in the capital-labor ratio. The increase of MRS_{kl} seems to be intuitively reasonable. The more capital (relative to labor) that is used, the less able capital is to substitute for labor. In a sense, capital becomes less potent as more of it is used.

F. Estimation of AES Between Capital and Labor in Libya

The share equations are:

$$S_{kL} = a_1 + b_{11}\ln X_1 + b_{12}X_2; \qquad 6.13$$

$$S_{LL} = a_2 + b_{12}\ln X_1 + b_{22}X_2; \qquad 6.14$$

where S_{kL} and S_{LL} are capital and labor share, respectively. The results of the estimates are:

$$S_{kL} = .614 + \underset{(2.60)}{.0386}\ln X_1 - \underset{(2.60)}{.0386}\ln X_2 \qquad 6.15$$

and

$$S_{LL} = .386 - .0386 \ln X_1 + .036 \ln X_2 \qquad 6.16$$

All coefficients are significant at a confidence level of 95 percent. Using the estimated parameters together with estimates of the remaining parameters, we compare the elements of $|\bar{F}|$ and calculate $|\bar{F}_{12}|$. Using (2.20), the Allen partial elasticity of substitution between capital and labor is estimated to be $\sigma_{kL} = .587$.

For the purpose of checking the monotonicity condition and the concavity condition, the distributive share values at sample mean and the Hessian matrix of partial second derivative are evaluated as follows. First, the results indicate that the estimated parameters have significant t statistics at the 5 percent level of significance. Second, the distributive share values, evaluated at sample means of capital and labor, exhibit positive signs:

$$S_{kL} = .659 > 0;$$

$$S_{LL} = .341 > 0.$$

Therefore, the monotonicity condition is satisfied.

The Hessian matrix of partial second derivatives,

$$H = \begin{vmatrix} f_{11} & f_{12} \\ f_{21} & f_{22} \end{vmatrix} = \begin{vmatrix} -.000463 & .001568 \\ .001568 & -.00536 \end{vmatrix}$$

$$= +.00000237$$

shows that although H does not exhibit a negative sign, its value is virtually zero. This indicates that the concavity condition is satisfied.

The Allen elasticity of substitution between Libyan capital and labor, σ_{kL} = .587, is positive, which indicates that the relationship between capital and labor is similar to that of Egypt. The implication is that an increase in the price of capital of one percent will increase the amount of labor by 0.587 percent.

The AES declined between 1962 and 1977, as shown in Table 6-6. The decline, which reflects the increasing difficulty of substituting capital for labor, is a strong confirmation of labor scarcity vis-a-vis the capital abundance. This also can be seen in the marked increase in the share of capital (from .596 to .688) and in the decline in the share of labor. The only exception to this pattern is the period from 1971 to 1974, where AES increased reflecting the influx of foreign labor.

TABLE 6-6.
ESTIMATES OF THE AES FOR THE LIBYAN ECONOMY

Year	AES of capital for labor	Distributive Shares S_K	S_L
1962	.540	.5964	.4036
Mean values	.587	.6592	.3401
1972	1.218	.6852	.3148
1977	.513	.6861	.3139

G. AES and Income Share

The average factor shares for capital and labor are .660 and .340, respectively. The share of Libyan capital is much higher than the share of Egyptian capital, and the opposite is true in

the case of labor shares. These estimates are expected, and reflect the initial factor endowment of each country. However, the share of capital in Libya appears to be high and is probably biased upward for two reasons. First, capital share is taken as property income from the national income account. This means that a large percentage of the oil revenue is included. As mentioned earlier, that revenue does not translate into productive capital, and the part which does always has a lag time. Second, due to insufficient data about the capital stock, estimates of gross fixed capital formation were taken as substitutes. Although the estimates are adjusted for inventory and depreciation, they remain an approximation to the capital stock. Furthermore, those estimates are probably affected by the same upward biases affecting capital share.

The small value of σ indicates that the substitution between Libyan capital and labor is not easy. The sharply curved isoquant implies that the marginal rate of substitution changes by a substantial amount as K/L changes. Within each economy, the low level of elasticity implies that the share of the factor whose price rises (declines) will also rise (decline). Next we will consider the relationship between σ and factor shares when factors of production are reallocated.

H. Policy Implications of Resource Allocation

The effects of allocating resources discussed in Chapter 5 will be examined under three scenarios. In the first, we assume that only capital will be transferred from Libya to Egypt. In the

second, we assume that only labor will be transferred to Libya. In the third, we assume that capital is transferred from, and labor is transferred to, Libya.

1. The first scenario

Transfer of capital from Libya to Egypt (a reduction in the total capital stock) will result in higher prices of capital, the rise depending on "how much" capital is transferred. Due to the capital surplus in Libya, a significant amount needs to be transferred before prices will start to rise.

The effect of higher prices of capital will change the amount of labor in the production process. Although labor and capital are substitutes, most likely the higher prices will not induce a substitution on a large scale, since $\sigma_{kL}<1$, which reflects labor scarcity.

The decline in the capital stock and the moderate rise in its prices will probably lead to a small increase in the capital share. The share of labor most likely will decline only slightly, since the decline in capital prices will not induce much substitution. Finally, we have shown that the aggregate production function is well behaved (Appendix D) and because f_{kL} is positive. A decline in the capital stock will lead to a lower marginal productivity of labor.

2. The second scenario

Labor transfer to Libya without capital transfer in the opposite direction will lead to an increase in the absolute and relative size of the labor force, which in turn will result in lower

prices of labor. However, the lower prices will not lead to a large-scale substitution of labor for capital immediately because $\sigma_{kL}<1$. Over time, substitution will most likely become easier; in the long run, there will be a decline in the capital share and an increase in the labor share. The productivity of capital will tend to increase, probably significantly.

3. The third scenario

Reducing the capital stock due to capital transfer from Libya to Egypt will result in a moderate increase in its prices. Because of the difficulty of substituting labor for capital, the capital share will increase (given that the amount transferred does not outweigh the price increase). This increase will be at least partially offset by the labor transfer in the opposite direction. The lower prices of labor will most likely initiate, in the long run, substitution of labor for capital, leading to a decrease in the capital share and an increase in the labor share. The effect on productivity, however, will be clearer and much easier to predict. Both transfers will work to decrease the capital-labor ratio, thus leading to higher capital productivity. Finally, it should be noted that the effect of allocating capital and labor from and to Libya will work in the opposite direction; the first transfer will most likely work to increase the capital share, while the second will work to decrease it.

I. Summary

The measurement of the aggregate production function for the Libyan economy revealed the capital-intensive nature of the economy as a whole. This conclusion was supported by the factor intensity analysis of capital and labor. The productivity estimates tend to confirm the hypothesis of high productivity of Libyan labor relative to Egyptian labor. This is due to the abundance of capital, at least part of which is translated into investment in human capital, which ultimately enhanced the productivity of labor.

The estimate of the elasticity of substitution between capital and labor indicates that it is "difficult" to substitute capital for labor. This difficulty is a reflection of the scarcity of labor. When the estimate was used to evaluate the impact of allocation of resources under three different scenarios, the analysis seems to suggest that transfer of capital to Egypt coupled with labor transfer in the opposite direction will lead to a decrease in the capital-labor ratio, thus leading to a higher capital productivity. The effect of allocating capital and labor from and to Libya will work in the opposite direction; the first transfer will most likely work to increase the capital share, while the second will work to decrease it.

Chapter 7

The Integrated Economy

A. Introduction

In Chapters 5 and 6 we estimated separate production functions for Libya and Egypt. In order to examine the effect of factor economic integration, a pooled production function for the integrated economy has to be estimated. Pooling two production functions for two different economies is rather cumbersome, because of the large number of variables and highly inaccurate method, because of the aggregative nature of the process itself, which usually poses both theoretical and empirical problems. The first problem is minimized by considering only the major variables (capital and labor) in each economy. The second can be ameliorated only slightly, however, by looking for other estimates that support the pooled results and by the interpretation and weight given to the final result.

B. The Pooled Production Function

We are interested in finding out whether the set of coefficients in the two production functions are equal. Among the standard statistical tools available for this purpose is analysis of variance, which is useful if we want to find out whether the intercepts differ, given that the slopes are equal. If, instead, we want to know whether the slopes differ, the appropriate technique is analysis of covariance. Actually, if the slopes differ, there is little point in testing for the equality of intercepts.

The Chow test (Chow, C.G., pp. 591-605), basically an analysis of covariance, is designed to test whether the regression coefficients estimated by assigning subsets of a given set of observations to two or more different structures do in fact belong to the same structure. A major shortcoming is that if two regressions are different, the test will show that they are different without specifying the source(s) of difference; that is, whether due to the intercept, the slope, or both. A superior test, suggested by Gujarati (Gujarati, D. , 18-21), uses dummy variables and proceeds as follows.

Use of dummy variables in testing for structural differences.

The two production functions for Libya and Egypt, respectively, are:

$$\log Q_{1i} = a_i + \alpha_1 \log L_{1i} + \beta_1 \log K + U_{1i} \quad i=1,\ldots 16; \qquad 7.1$$

$$\log Q_{2i} = a_2 + {}_2\log L_{2i} + {}_2\log K + U_{2i} \quad i=1,\ldots 16. \qquad 7.2$$

The subscripts 1 and 2 refer to the two sets of observations, and the U's are stochastic error terms. It is assumed that U_2 has the same normal distribution as U_1, with variance-covariance matrix I an identity matrix of the appropriate order.

The dummy variable approach can best be illustrated by writing the pooled function as follows:

$$Q_i = a_0 + a_1 \log D + a_2 \log L_i + a_3 \log K_i + a_4 \log \overset{*}{L}_i + a_5 \log \overset{*}{K}_i + U_i \quad i=1,\ldots 32. \qquad 7.3$$

where D = dummy variable = 1 if the observation lies in the first

set, that is, Libya; and it equals 0 if the observation lies in the second set, that is, Egypt. In addition,

$$\overset{*}{K}_i = DXK_i,$$

$$\overset{*}{L} = DXL_i.$$

The dummy variable D is introduced in 7.3 in the additive and multiplicative forms. The coefficient a_1 is the differential intercept, and a_4 and a_5 are the differential slope coefficients. If a_1 is statistically significant, the intercept value of the Libyan production function is obtained by $a_1 + a_0$, a_0 in this case being the intercept value of the Egyptian production function. If a_1 is statistically insignficant, then a_0 gives an estimate of the common term of both functions. If a_4 is statistically significant, the labor coefficient of the Libyan production function is $a_4 + a_2$, a_2 being the labor coefficient of the Egyptian function in this situation. If a_4 is statistically insignificant, a_2 gives the labor coefficient common to both functions. If a_5 is statistically significant, the capital coefficient of the Libyan production function is $a_5 + a_3$, a_3 being the capital coefficient of the Egyptian function. If a_5 is statistically significant, a_3 gives the capital coefficient common to both functions.

Thus, with the help of the additive and multiplicative dummies, we can tell whether two linear regressions differ either in the intercept or the other coefficients. Finally, it should be pointed out that it is immaterial whether D=1 for observations in the first set or in the second set. The results are invariant.

C. Estimation of the Pooled Regression

Recall that the estimated production functions for Libya and Egypt, respectively, are:

$$\log Q_t = -3.80 + 1.17 \log L + .70 \log K; \qquad 7.4$$

$$\log Q_t = -4.11 + 1.22 \log L + .29 \log K. \qquad 7.5$$

The estimate obtained for the pooled function 7.3 is:

$$\log Q_t = \underset{}{-4.11} + \underset{(.067)}{.31 \log K} + \underset{(2.34)}{1.22 \log L} + \underset{(2.33)}{.29 \log K} -$$

$$\underset{(.054)}{.41 \log \overset{*}{L}} + \underset{(2.00)}{.42 \log \overset{*}{K}}. \quad \bar{R}^2 = .97 \qquad 7.6$$

Equation 7.6 shows that, first, the differential intercept is insignificant at the 5 percent level, implying that the intercept is not different for the two production functions. The common intercept is given by a_0 (-4.11). Actually, the common intercept is close to that of equation 7.5. This indicates that the intercept of the Egyptian production function can be used as the intercept for the combined production function. Second, the differential coefficient of labor, a_4, is statistically insignificant at the 5 percent level, implying that the coefficient of labor is the same for both economies. The common coefficient is given by a_2 (1.22). Again, it should be noted that this is very close to the estimate of the labor coefficient of the Egyptian production function given in equation 7.5, and thus the coefficient from equation 7.5 will be used as the labor coefficient for the pooled regression. Third, the differential coefficient of capital, a_5, is marginally signifi-

cant at the 5 percent level, implying that the capital coefficient for Egypt is different from the capital coefficient for Libya. Following the earlier discussion, then, the capital coefficients of Libya and Egypt are (.42 + 29) and (.29), respectively. Comparing these values with those given by equations 7.5 and 7.6, we can see that they are identical.

In summary, in pooling the two functions we find no structural differences in the intercept or in the labor coefficients. The only structural difference lies with the capital stock. This is not surprising, however, since in pooling the two economies the quantity of labor "added" to the Egyptian labor force is very small relative to the amount added to the capital stock. This is most likely the reason for the significance of the differential coefficient of capital. Furthermore, this probably indicates that the new integrated economy will be more capital intensive. If a_2 and a_4 are dropped from equation 7.6, and if the new estimate shows no significant change in the remaining coefficients, then this can be a sufficient ground for pooling the two production functions.

Equation 7.7 shows the estimate when the variables D and $\overset{*}{L}$ are dropped:

$$\log Q_t = \underset{}{-3.8} + \underset{(8.06)}{1.19} \log L + \underset{(3.07)}{.29} \log K + \underset{(6.90)}{.41} \log \overset{*}{K}, \qquad 7.7$$

$$\bar{R}^2 = .97$$

All coefficients are highly significant at the 5 percent level. Comparing equation 7.7 to 7.6, it can be seen that there is no significant change in the coefficients of L, K, and $\overset{*}{K}$.

D. Estimation of AES Between Capital and Labor in the Integrated Economy

The results of the "pooled" share equations are:

$$S_K = .526 - \underset{(15.13)}{.1213}\ln\overset{*}{X}_1 - \underset{(15.31)}{.1213}\ln\overset{*}{X}_2 \quad \bar{R}^2 = .88 \qquad 7.8$$

$$S_L = .474 + .1213\ln\overset{*}{X}_1 - .1213\ln\overset{*}{X}_2 \qquad 7.9$$

Both coefficients are significant at confidence level of 95 percent. Using the estimated parameters together with estimates of the remaining parameters [implied by the restrictions $b_{ij} = b_{ji}$ $(i \neq j)$] and constant returns to scale, we compute the elements of $|\bar{F}^*|$ and calculate $|\overset{*}{F}_{12}|$. Using 2.20, the Allen partial elasticity of substitution between capital and labor is estimated to be .728.

The distributive share values evaluated at sample means of capital and labor exhibit positive signs:

$$S_K = .657 > 0$$

$$S_L = .343 > 0$$

Therefore, the monotonicity condition is satisfied. The Hessian matrix of partial second derivatives,

$$|\overset{*}{H}| = \begin{vmatrix} f_{11} & f_{12} \\ f_{21} & f_{22} \end{vmatrix} = \begin{vmatrix} -.0001042 & .0003768 \\ .0003768 & -.0001284 \end{vmatrix}$$

$$\bar{H}^* = -.00000001$$

shows that $\overset{*}{H}$ exhibits the semi-definite sign ($|\bar{H}^*|<0$); that is, $\overset{*}{H} = -.00000001<0$, or virtual zero value. This indicates that the concavity condition is also satisfied. The satisfaction of both

conditions suggests that, in general, the aggregate production function for the Egyptian economy is well behaved according to economic theory.

The value of the AES indicates that substitution between capital and labor in the integrated economy is "somewhat difficult." As expected, the AES value is higher than the AES of Libya and lower than that of Egypt. The difficulty of substitution probably stems from the capital-intensive nature of the "new" economy as reflected in the higher share of capital (0.657). This is due to the fact that the quantity of labor "added" to the Egyptian labor force is very small relative to the amount added to the capital stock. This difficulty, especially in the initial phases, will most likely dissipate, as the re-allocated financial capital translates into physical capital.

To test for technological changes, a translog production function similar to 5.20 was fitted for the pooled economy, and the estimate for the unrestricted version is:

$$\underset{}{S_K} \underset{(46.23)}{=} \underset{}{.523} \underset{(2.33)}{-} \underset{}{.00014T} + \underset{(16.40)}{.12\log(X_1/X_2)} + \underset{(.53)}{.000003\log X_3} \quad 7.10$$

The log of the likelihood function = 238.9 when the restrictions that $a_2 = 0$ and $B_{13} = 0$ are imposed. The log of the likelihood function for the restriction version is 226.1 using 5.22 from Chapter 5. The computed value of χ^2 with two degrees of freedom is 25.6. Based on this, we reject the hypothesis that a_2 and B_{13} are equal to zero, which means that technological changes for the integrated economy are non-neutral.

E. Productivity Measurements

The pooled regression may be particularly useful in output prediction; it cannot be used for estimates of input productivity since there are no "observations" for that regression. Furthermore, the technical relation between capital and labor is determined for each regression, but for the pooled regression the relation is not known. For these reasons, it makes little sense to estimate the productivity of inputs based on equation 7.7. To overcome this obstacle, the estimates can be made for each regression separately under the different scenarios stated earlier in Chapters 5 and 6.

Table 7-1 shows the productivities of Egyptian labor and capital under the second scenario. Recall that in that situation, we assume only capital is transferred from Libya to Egypt. The estimates in Table 7-1 are based on the assumptions that two billion dollars will be transferred and that technology remains the same across Egypt.

As a result of the capital transfer, the marginal productivity of labor will increase, in the average, by 16 percent. This can be seen from the comparison between Table 7-1 and Table 5-2. At a very low level of capital stock, such as existed in the years 1962-1972, the increase in productivity of labor is much higher, averaging about 46 percent. The increase will be smaller, the higher the capital stock becomes. As expected, the transfer of capital will lead to a decline in the overall productivity of capital. The estimates show another sharp decline in MPK, which will be cut more than half. However, these estimates are most likely

TABLE 7-1.

MPL AND MPK FOR EGYPT UNDER SECOND SCENARIO,
ASSUMING TWO BILLION DOLLARS ARE TRANSFERRED TO EGYPT

Year	MPL per Year	MPL per Day	Per Hour	MPK
1962	1177.50	3.35	.42	.49
1963	1201.53	3.42	.43	.49
1964	1221.28	3.50	.44	.50
1965	1221.80	3.50	.44	.53
1966	1231.60	3.50	.44	.56
1967	1227.60	3.50	.44	.58
1968	1209.71	3.45	.43	.61
1969	1242.46	3.50	.44	.62
1970	1248.10	3.60	.44	.59
1971	1255.69	3.60	.45	.61
1972	1276.50	3.60	.45	.65
1973	1290.50	3.70	.46	.61
1974	1321.73	3.80	.47	.61
1975	1404.34	4.00	.50	.54
1976	1442.56	4.11	.51	.55
1977	1496.67	4.26	.53	.53

TABLE 7-2.

MPL AND MPK FOR LIBYA UNDER SECOND SCENARIO,
ASSUMING TWO MILLION WORKERS ARE TRANSFERRED TO LIBYA

Year	MPL per Year	MPL per Day	Per Hour	MPK
1962	2313.22	6.50	.82	12.06
1963	2568.53	7.37	.92	13.51
1964	3374.77	9.62	1.20	10.54
1965	4504.06	12.80	1.60	9.45
1966	5401.79	15.38	1.92	8.88
1967	5873.42	16.73	2.10	8.71
1968	7307.37	20.81	2.60	8.10
1969	7847.81	22.36	2.79	7.90
1970	5994.69	17.08	2.14	9.10
1971	7643.10	21.78	2.72	9.20
1972	10147.43	28.91	3.61	7.69
1973	14538.76	41.40	5.18	6.88
1974	19692.40	56.10	7.01	6.34
1975	22224.50	63.32	7.90	6.21
1976	22706.67	64.70	8.00	6.22
1977	25891.90	73.77	9.24	6.19

biased downward because it is assumed that the transferred assets will be changed immediately into physical capital, which most probably will not be the case.

Table 7-2 shows the estimates of the marginal productivity of Libyan labor and capital. Under the second scenario, which assumes that only labor is transferred to Libya. The increase in the absolute and relative size of the labor force will lead to lower prices of labor. However, this will not result in a large-scale substitution of labor for capital immediately because $\sigma_{KL}<1$. Over time, substitution will most likely become easier, and the productivity of capital will tend to increase, probably significantly.

The estimates in Table 7-2 are based on the assumption that two million workers are transferred to Libya with no change in the capital stock. As expected, there is a significant increase in the productivity of capital when the estimates of Table 7-2 are compared to the estimates of Table 6-1. The increase in the marginal productivity of capital averages about 600 percent. The productivity increment is even higher in the earlier year, when the existing labor force is small.

F. The Efficient Allocation of Resources

Efficiency in production requires that an economy with fixed resources allocate them among various uses in a way such that the rate of technical substitution (MRS) or any two inputs is the same in the production of every output the country produces. This is Rule 1, and the implication is that production should be using

all available resources, such that an increase in the production of certain outputs would necessitate the transfer of resources from the production of another output. The locus of these efficient points (where MRS_k for 1, for example, is equal to all outputs) can be used to derive the production possibility frontiers. The conditions required in Rule 1 are necessary only for the true maximum. For these conditions to be sufficient, the isoquants must have "normal" shapes, that is, convex toward the origin.

Rule 2 concerns the efficient allocation of resources among two economies with fixed resources and requires that these resources be allocated in some efficient way among them in order to ensure overall productive efficiency. Intuitively, resources should be allocated to the economy where they can be most efficiently used. More precisely, the condition for efficient allocation is that resources should be allocated so that the marginal physical product of any resource in the production of output $X_i A$ should be the same as $X_i B$. To show the necessity of this rule, consider a situation in which it does not hold. Suppose that the marginal physical product of labor in the production of output X is 5X per extra man-hour in Economy A, and only 3X in Economy B. Then a transfer of one unit of labor from Economy B to Economy A would increase the total output of both economies by 2X. Clearly, the initial allocation of labor was inefficient, and this transfer of labor should be continued until allocation Rule 2 is fulfilled.

Rule 3 involves the efficient choice of output by the two economies. If they produce the same output, they must operate

at points on their respective production possibility frontiers at which their rates of output transformation are equal. This result is particularly interesting because it shows that output may be increased by having each economy produce the "correct" output combinations. One additional condition of efficiency is at least implied in the three rules. Resources must be fully employed; so long as a resource has any positive productivity, it would be inefficient to leave it idle.

These three rules summarize the conditions which must hold if production is to be efficient. The operation of the rules can be visualized as follows: Rule 1 determines the "size" of each economy production possibility frontier, Rule 2 determines the shape of those frontiers, and Rule 3 determines where on the frontiers production will take place. It is obvious, of course, that the three rules are not independent of one another, and any one of them can be derived from the other two.[1]

The existing allocation of resources in Egypt and Libya is depicted in Figure 7-1. The dimensions are given by the total quantities of available capital and labor: the horizontal dimension represents the total quantity of capital ($\bar{K}$) available, whereas the

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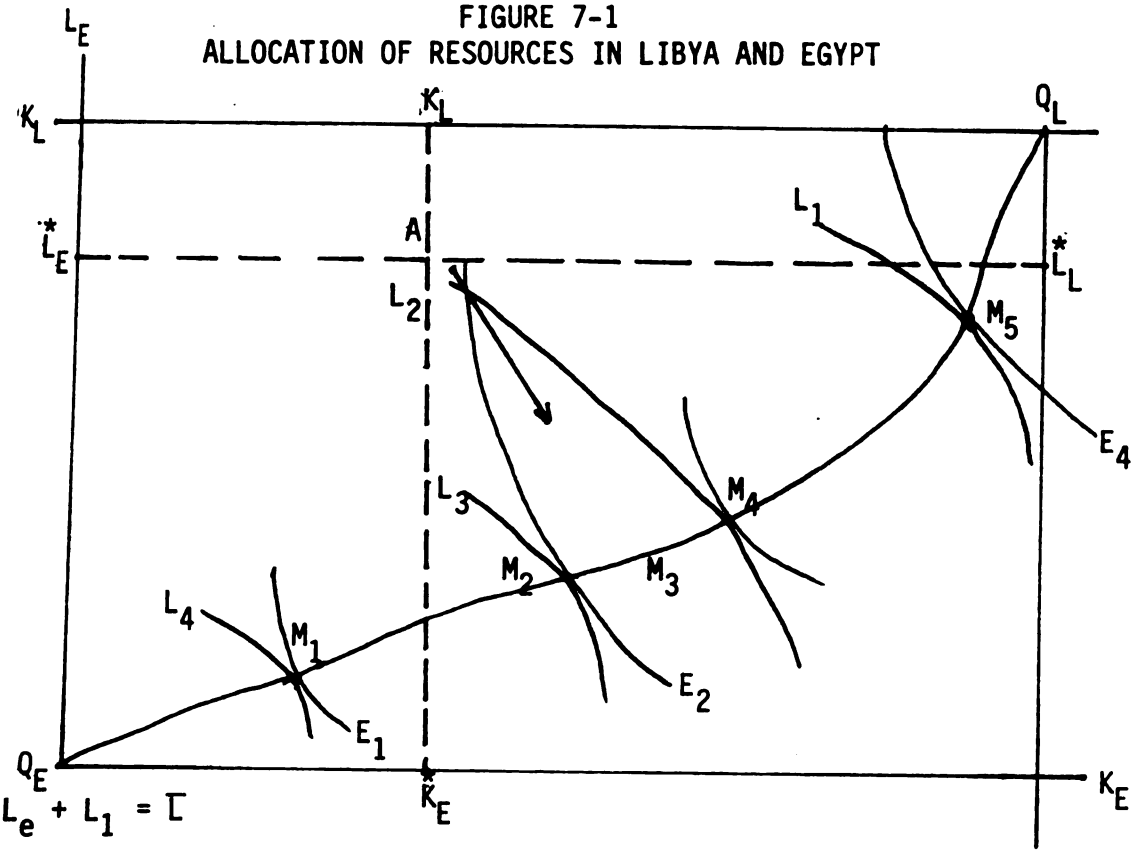
[1] For each economy, these rules imply that the MRS_k for 1 should be equal, or as close thereto as possible, in the production of all goods. If we choose economic sectors instead of goods, then the MRS_k for 1 of agriculture should equal that of manufacture. However, this was not the case, as we have seen, since, for example, the MPL for agriculture was lower than that of manufacture. This indicates different MRS's. Furthermore, these rules require that each economy operate along its production possibility frontier, which, as we have shown, is not the case, since both economies possess ideal resources.

FIGURE 7-1
ALLOCATION OF RESOURCES IN LIBYA AND EGYPT



$L_e + L_1 = \bar{L}$

$K_e + K_1 = \bar{K}$

Q_e = Egyptian output

Q_1 = Libyan output

the vertical dimension is total quantity of Labor ($\bar{L}$) available. The vertex Q_e is used as the origin for an isoquant map for Egypt, and the vertex Q_1 is used as the origin for an isoquant map for Libya. Movements in the northeasterly direction on this map represent a higher level of output for the Egyptian economy; movements in a southwesterly direction represent increases in Libyan output. Any point within the box represents an allocation of the available resources between the two countries. The locus of efficient points is given by the points of tangency of various isoquants. At these

points, the MRS of K for L for Egypt is equal to that for Libya.

The actual allocation of resources of both countries is approximated by the point A. At that point, the initial endowments are depicted; Libya uses more capital and less labor, and the opposite is true for the Egyptian economy. Let us assume, for example, that point A represents the output of the Libyan economy in 1977, at which time the MRS K for L is equal to $10,595.80. At the same point for the same year, MRS K for L for the Egyptian economy is equal to $1,490. The initial allocation is distinctly inefficient in that both economies can be made better off by moving to a point on the Q_eQ_l curve. This would be true, for instance, if the allocation M_3 were chosen rather than A. There are two basic reasons for the inefficiency of the initial allocation of point A. First, the productivity of Libyan capital is low relative to Egyptian capital, and the opposite is true in the case of labor. This is why the MRS K for L differs for the two economies at point A, or for that matter, any other actual allocation. Second, at the same point, both economies operate below their production possibility frontiers. This is due to labor redundancy in the case of Egypt, and to capital surplus in the case of Libya.

In the context of one economy, an inferior point such as A will not be chosen; rather, a new efficient point will be chosen at which the MRS K for L should be equal for both economies. The movement to a new efficient point requires the reallocation of resources which should be carried out to the point where the marginal physical product of any resource in the production process is the

same no matter which economy produces that particular output. Because MPL for Libya is high, labor should be transferred from Egypt to Libya, and this transfer should be continued until Rule 2 is fulfilled; that is, until labor productivity is equal in both economies. The process of equalization will be enhanced by capital transfer in the opposite direction. The capital productivity for Libya is low. Capital should be allocated from Libya to Egypt until both marginal productivities of capital are equal in both economies. The transfer of resources in this way also helps speed the process of optimization. In the case of Egypt, for example, the effect of the reallocation of resources works in the same direction. The transfer of surplus labor will lead to an increase in the productivity of the remaining Egyptian labor force, the obvious reason being that labor will have more capital available to work with. The availability of capital has two sources: the transfer of the labor surplus and the capital transfer form Libya. This process works in the opposite direction, such that it will tend to reduce the MPL and increase the MPK in Libya. Exactly which allocation on the segment m_2, m_4 might be chosen depends on how "much" of the resources will be transferred and their proportions relative to each other.

The efficiency locus can be used to derive the production possibility frontiers. By considering different efficient allocations ranging from Q_e to Q_1, the integrated economy frontier is traced out. Moving along this efficiency locus, resources are being transferred from the production of Q_e into the production of Q_1, or vice versa. The PPF is therefore negatively sloped,

reflecting the efficiency notion that more Q_e can be produced only by giving up some Q_1. The slope of the frontier at which Q_e can be traded for Q_1 is called the rate of output transformation. The derivation of the production possibility frontier for the integrated economy can be achieved through the maximization of the two production functions.

G. The Production Possibility Frontier for the Integrated Economy

First: Maximization with no prior constraints. The Egyptian and Libyan production functions are:

$$Q_E = A_E L_E^{\alpha_E} K_E^{\beta_E} \qquad 7.11$$

$$Q_L = A_L L_L^{\alpha_L} K_L^{\beta_L} \qquad 7.12$$

The objective is to maximize the Egyptian production function subject to the following constraints:

$$Q_L = A_L L_L^{\alpha_L} K_E^{\beta_E} \qquad 7.13$$

$$L_E + L_L = \bar{L}$$

$$K_E + K_L = \bar{K}$$

where $\bar{L}$ and $\bar{K}$ are the total labor and capital available in both economies. Thus,

$$Q_E \cdot A_E L_E^{\alpha_E} K_E^{\beta_E} - \lambda_1 (Q_L - A_L L_L^{\alpha_L} K_L^{\beta_L}) \qquad 7.14$$

$$- \lambda_2 (\bar{L} - L_E - L_L)$$

$$- \lambda_3 (K - K_E - K_L)$$

Taking the partial derivatives with respect to L_E, K_E, L_L, and K_L,

$$(1)\quad \frac{\partial Q_E}{\partial L_E} = \alpha \frac{Q_E}{L_E} + \lambda_2 \quad \text{or} \quad MP_{L_E} = -\lambda_2 = \alpha_E \frac{Q_E}{L_E}$$

$$(2)\quad \frac{\partial Q_E}{\partial K_E} = \beta_E \frac{Q_E}{K_E} + \lambda_3 \text{ or} \quad MP_{K_E} = -\lambda_3 = \beta_E \frac{Q_E}{K_E}$$

$$(3)\quad \frac{\partial Q_E}{\partial L_L} = \lambda_1 \alpha_L \frac{Q_L}{L_L} + \lambda_2 \quad \text{or } -\lambda_2 = \lambda_1 \alpha_L \frac{Q_L}{L_L}$$

$$(4)\quad \frac{\partial Q_E}{\partial K_L} = \lambda_1 \beta_L \frac{Q_L}{K_L} + \lambda_3 \quad \text{or } -\lambda_3 = \lambda_1 \beta_L \frac{Q_L}{K_L}$$

Substituting for λ_2 in equation (3) will lead to equating the marginal productivity of labor in both economies:

$$\lambda_1 \alpha_L \frac{Q_L}{L_L} = \alpha_E \frac{Q_E}{L_L} = \alpha_E \frac{Q_E}{L_E} \quad \text{or} \quad \lambda_1 = \frac{Q_E}{L_E} \cdot \frac{\alpha_E}{\alpha_L} \cdot \frac{L_L}{Q_L} \qquad 7.15$$

Substituting for λ_3 in equation (4) and equating the marginal productivities of capital in both economies:

$$\lambda_1 \beta_L \frac{Q_L}{K_L} = \beta_E \frac{Q_E}{K_E} \quad \text{or} \quad \lambda_1 = \frac{\beta_E}{\beta_L} \cdot \frac{Q_E}{K_E} \cdot \frac{K_L}{Q_L} \qquad 7.16$$

Using equations 7.12 and 7.13,

$$\frac{\alpha_E}{\beta_E} \frac{K_E}{L_E} = \frac{\alpha_L}{\beta_L} \frac{K_L}{L_L} \qquad 7.17$$

Equation 7.17 satisfied the first rule, which states that given the fixed resources of both economies, these resources should be allocated "between them" in ways such that the rate of technical substi-

tution of capital and labor is the same in the production of Q_E and Q_L. The left-hand side of equation 7.17 is the MRS of (K for L) for the Egyptian economy, and the right-hand side of the MRS of (K for L) for the Libyan economy.

There are six unknown variables: Q_E, Q_L, L_E, L_L, K_E, and K_L, and five equations:

$$(1) \quad Q_E = A_E L_E^{\alpha_E} K_E^{\beta_E}$$

$$(2) \quad Q_L = A_L L_L^{\alpha_L} K_L^{\beta_L}$$

$$(3) \quad L_E + L_L = \bar{L}$$

$$(4) \quad K_E + K_L = \bar{K}$$

$$(5) \quad \frac{\alpha_E}{\beta_E} \cdot \frac{K_E}{L_E} = \frac{\alpha_L}{\beta_L} \cdot \frac{K_L}{L_L}$$

From equation (1),

$$L_E = \left(\frac{Q_E}{A_E (\bar{K} - K_L)^{\beta_L}} \right)^{1/\alpha_E}$$

and from equation (2),

$$L_L = \left(\frac{Q_L}{\beta_L K_L^{\beta_L}} \right)^{1/\alpha_L}$$

but since $L_E + L_L = \bar{L}$, then

$$\left(\frac{Q_E}{A_E(\bar{K}-K_L)^{\beta_E}}\right)^{1/\alpha_E} + \left(\frac{Q_L}{A_L K_L^{\beta_L}}\right)^{1/\alpha_L} = \bar{L} \qquad 7.18$$

Substituting in equation (4) for K , L , and L yields

$$\left(\frac{Q_L}{A_L K_L^{\beta_L}}\right)^{1/\alpha_L} / \left(\frac{Q_E}{A_L(\bar{K}-K_L)^{\beta_E}}\right)^{1/\alpha_E} = \frac{\alpha_L}{\alpha_E} \cdot \frac{\beta_E}{\beta_L} \cdot \frac{K_L}{\bar{K}-K_L} \qquad 7.19$$

Second: Maximization <u>with prior</u> constraints. If we imposed the constraints that:

$$\alpha_E = \alpha_L$$

and

$$A_E = A_L$$

then the same process will yield

$$\left(\frac{Q_E}{(\bar{K}-K_L)^{\beta_E}}\right)^{1/\alpha} + \left(\frac{Q_L}{K_L^{\beta_L}}\right)^{1/\alpha} = \bar{L} \qquad 7.20$$

$$\left(\frac{Q_L}{Q_E}\right)^{1/\alpha} \left(\frac{\bar{K}-K_L}{K_L^{\beta_L}}\right)^{1/\alpha} = \frac{\beta_E}{\beta_L} \left(\frac{K_L}{\bar{K}-K_L}\right) \qquad 7.21$$

Given the fixed stocks of K and L, the efficiency locus in Figure 7-1 shows the maximum output of Q_E which can be produced for any pre-assigned output of Q_L. The QQ_E, QQ_L locus is transferred to Figure 7-2. At QQ_E, for example, no resources are devoted to Libyan output; consequently the Egyptian output will be as large as possible with the existing resources. Similarly, at QQ_L the

Libyan output is as large as possible.

To calculate the point along the production possibility frontier, first we choose an appropriate value for the total capital stock, $\bar{K}$. The sum of the capital stock for 1976, which is \$6.8191 billion, was chosen. Second, the number of the labor force was chosen to be fixed at the 1976 level of 9.4497 million workers. Third, using selective values of K_L and substituting in equation 7.18 and 7.19, we can obtain the corresponding values of Q_E and Q_L. These points can be used to construct the actual production possibility frontier for the integrated economy. Table 7-3 shows the estimated values of Q_E and Q_L and Figure 7-2 shows the corresponding production frontier.

When K_L = 500 million dollars,(K_E = 6319.1). The Egyptian output is almost at maximum and the Libyan output is approaching zero. As the movement proceeds in a southeastern direction, the trade-off will result in a higher output of Q_L and a lower output of Q_E. The marginal productivity of Egyptian capital at point M_1, for example, will be very low; on the other hand, at the same point we would expect that the marginal productivity of Libyan capital will be very high for the simple reason that the level of capital stock is very small. Thus, a movement from point M_1 to M_2. An increase in the Libyan capital stock from \$500 to \$1000 million will increase the output of Libya from \$108.9 to \$367.3 million. However, as we move along the frontier, Q_L will be increasing at a decreasing rate. The rationale is that increasing the capital stock will after a point result in a decrease in the marginal productivity of capital or in-

TABLE 7-3.

THE ESTIMATED VALUES FOR Q_E and Q_L
IN MILLION $

K_L	Q_L	Q_E
500	108.8491	2784618.0
1000	367.3225	2555101.3
1500	761.2049	2321332.4
2000	1300.4070	2096022.0
2500	1969.9850	1842619.6
3000	2805.2520	1601714.7
3500	3784.5720	1344128.6
4000	4713.2100	1146532.1
4500	6349.6710	8930012.0
5000	8093.8660	6341460.3
5500	10923.2530	4377295.0
6000	12295.2700	2126460.7

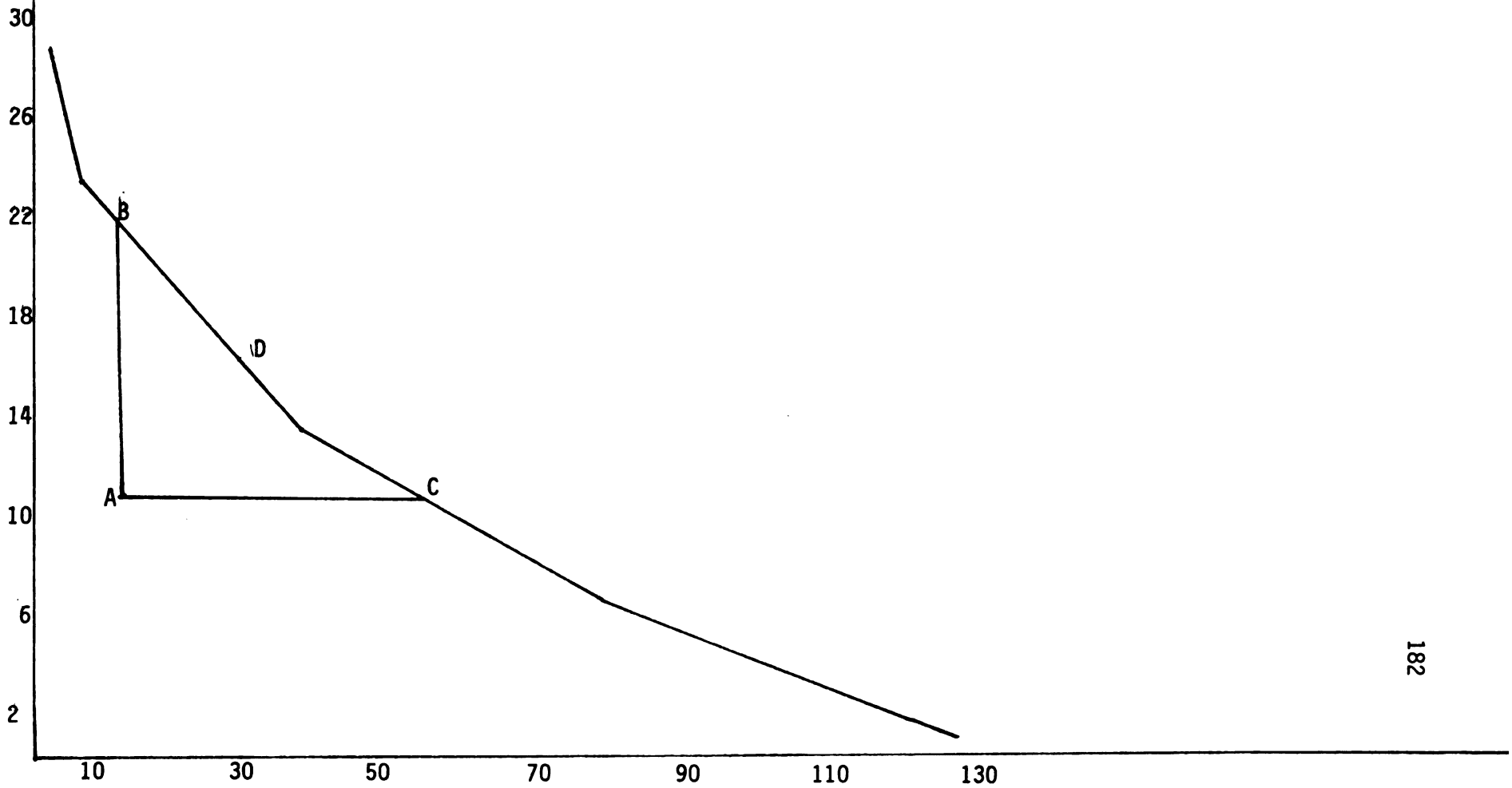
creasing the output of Q_L will raise its marginal cost. Whereas decreasing the output of Q_E will reduce its marginal cost. The rate at which Q_E can be traded for Q_L is called the rate of output transformation (ROT) and it is equal to

$$ROT = \frac{\partial Q_L}{\partial Q_E}$$

The slope of the production possibility frontier records how Q_E can be technically traded for Q_L while continuing to keep the available production inputs efficiently employed.

The gains from integration can be measured directly from Figure 7-2. Point A inside the frontier represents the actual output of Libya and Egypt ($167,777, $113,077 million) in 1976. Clearly the allocation is inefficient because output can be unambiguously increased. The inefficiency of allocation A stems from the allocation of capital and labor between the two economies. Since the area BAC is attainable, then both Q_E and Q_L can be increased by reallocating K and L. Measured by the horizontal distance, AC, the Egy- Egyptian output will increase by approximately 51 percent if the movement was from point A to C; if, on the other hand, the movement was from point A to B, then the Libyan output will increase by roughly 89 percent. Obviously the gains from integration can be distributed more evenly between the two economies by moving from point A to point D.

FIGURE 7-2
THE PRODUCTION POSSIBILITY FRONTIER
FOR THE INTEGRATED ECONOMY



Chapter 8

Conclusions

This study was an attempt to investigate the possibility of economic integration between Libya and Egypt. Both countries are of small economic size, which meant that development is limited by a number of constraints, the most important of which is the small domestic market. Furthermore, Libya enjoys a large surplus of financial capital which cannot be absorbed domestically, primarily due to the scarcity of skilled and unskilled labor. By contrast, there exists in the Egyptian economy a widespread labor redundancy coupled with an acute shortage of capital.

The main hypothesis underlying this study is that economic integration between Libya and Egypt is likely to be beneficial. The gain would be the result of a higher level of productivity of some of the factors of production and a higher level of output. The proposed mechanism through which integration can be achieved is the mobility of resources between the two economies, in particular labor and capital. Within this framework, factor integration requires the removal of discrimination between the economic agents. Furthermore, factor integration requires the formation and application of coordinated and common policies within and between states on a sufficient scale to ensure that the major economic and welfare objectives are fulfilled, including the allocation of resources in the most efficient way.

To build the case for economic integration, the basic structural

"deficiencies" in the initial factor endowments of each economy are explored in Chapters 3 and 4. Among the findings in Chapter 3 are the following: Libya enjoys a surplus of financial capital generated mainly by the production of oil. It was found that the surplus cannot be absorbed domestically because of limited absorptive capacity. Binding constraints (mainly lack of skilled and unskilled labor and entrepreneurship and limitations of nature) prevent the economy from efficiently absorbing more than 25 to 30 percent of its oil revenues. Based on the assumption that oil prices may level off but are not likely to experience a drastic decline, conserving oil in the ground is ruled out as an unproductive alternative. In view of the possibility of expropriation of some degree of interference by host governments and the hazardous effects of world inflation and devaluations of key currencies, international investment as an alternative is risky and uncertain.

Among the findings in the Egyptian economy is the existence of widespread labor redundancy. At 2.5 percent annually, the growth of the labor force is more than double that of DC's, with a fairly constant participation rate. This means that the Egyptian labor force grows by the same percentage as the total population. The average age of the population declined steadily in the past thirty years, resulting in a higher dependency ratio. This has an adverse effect on savings and investment because of the increase in consumption.

Labor redundancy is reflected in the higher level of unemployment, which stood at 7 percent in 1976. However, this level is biased downward for three major reasons. First is the higher level of external

migration, estimated to be 1.4 million workers in 1976. Although there is no valid reason to assume that all emigrants would have been unemployed in the absence of emigration, it is likely that external migration reduced unemployment substantially. Second, the government sector is characterized by large redundancies of unskilled labor. The most important employment-generating government policies have been the expansion of and over-staffing in the public sector, government as well as public enterprises. The schemes of guaranteed employment for university and other graduates and for military conscripts have greatly contributed to this result. Third, although agriculture is the leading sector in employment, its contribution to GDP is not only smaller than its share of employment, but the contribution is declining steadily, from 32 percent in 1961 to 25 percent in 1978. Such relative ratios are an indication of low productivity in agriculture. Marginal productivity in the agricultural sector has never been zero, but it is low enough to give merit to the notion that labor can be transferred from agriculture at no loss of output.

Estimates of the technical relationship between inputs and output showed that first, the Egyptian economy is labor intensive. This conclusion was supported by the factor intensity analysis of capital and labor. Second, using CD and the translog production functions, several formulations have been tried to test for technological changes and all the results indicate that technological changes have not been neutral during the period from 1962 to 1972. This conclusion is also reinforced by the fact that the ratio of marginal productivities of

capital and labor and their respective shares change over time.

Estimates of the productivities of Egyptian capital and labor showed that the productivity of labor increases, then decreases, then increases again. This behavior is consistent with the increase and decline in capital stock. The productivity estimates tend to confirm the hypothesis of low productivity of labor relative to other LCD's, and in particular to the productivity of Libyan labor. The productivity of capital is somewhat higher than that of labor. Yet the results are inconclusive when testing for the hypothesis that the rate of growth of capital productivity is higher than that of labor.

The estimate of the Allen elasticity of substitution indicates that it is easy to substitute Egyptian capital for labor. This, of course, is the expected result and it is another indication of the labor redundancy. The impact of allocation of resources under three different scenarios, suggests that the transfer of labor to Libya coupled with capital transfer in the opposite direction will lead to an increase in the productivity of labor. The enhancement will be due to the sharp increase in the capital-labor ratio. The share of capital will increase and the share of labor will most likely decrease as a result of the reallocation of resources.

The analysis of allocative efficiency and the optimal level of resources shows strong evidence of inefficiency in the Egyptian economy, particularly in the allocation of the labor force. Estimates of the labor surplus range from 1.9 to 6.9 million workers.

This wide margin points out the limitations of the analysis. However, it is important to observe that all estimates indicate a surplus of labor. The unsettled question is the size of that surplus.

The estimates of the aggregate production function for the Libyan economy revealed that: (a) The Libyan economy is labor intensive. This is a reflection of the fact that financial capital abundance does not translate immediately to productive capital. The fact is that Libya has to import all its capital goods, and the shortage of skilled and unskilled labor imposes major restrictions on domestic capacity and prevents the absorption of surplus capital. (b) The Libyan economy has been experiencing increasing returns to scale, which is probably mainly due to the oil sector. (c) Technological changes have been non-neutral. This conclusion is supported by the fact that the ratio of marginal productivities and their respective shares change over time.

The high productivity of Libyan labor is due to the abundance of capital facilitating the undertaking of a large-scale investment in human capital. However, the level of productivity is probably biased upward due to the oil sector and its unique position in the economy. Oil is a "cheap" resource for Libya; its production places little pressure on the domestic supplies of scarce resources, including labor. Since production does not compete for local factors of production, the opportunity cost involved is virtually zero. Thus, when productivity is estimated based on the output of that sector. it is not surprising that it is so high.

As expected, the AES estimate shows that substituting Libyan

capital for labor is difficult, which is another indication of the scarcity of labor in the Libyan economy. All the scenarios seem to suggest that transfer of capital to Egypt coupled with labor transfer in the opposite direction will lead to higher capital productivity. The effect of allocating capital and labor from and to Libya will work in the opposite direction. That is, the first transfer will most likely work to increase the capital share, while the second will work to decrease it.

In pooling the two production functions, we find no structural differences in the intercept or in the labor coefficients. The only structural difference appears in the capital stock. This is not surprising, however, since in pooling the two economies the quantity of labor added to the Egyptian labor force is very small relative to the amount added to the capital stock. This probably indicates that the new integrated economy will be more capital intensive.

As expected, the AES value is higher than the AES of Libya and lower than that of Egypt. It indicates that the substitution between capital and labor in the integrated economy is "somewhat" difficult. This is probably due to the capital intensive nature of the new economy as reflected in the high share of capital. This difficulty, especially in the initial phases, will most likely dissipate as the re-allocated financial capital translates into physical capital.

The pooled production function could not be used for the productivity estimates because of the lack of observations. However, estimates can be made for each regression separately under different

scenarios. Assuming that two billion dollars will be transferred and that technology remains the same across Egypt, the productivity of labor, on the average, will increase by 16 percent. On the other hand, the productivity of capital will be cut by more than half. The latter estimate is probably biased upward because it is assumed that the transferred assets will be changed immediately into physical capital, which will not be the case. Assuming that a million workers are transferred to Libya with no change in the capital stock, the increase in the productivity of capital averages about 600 percent. The productivity increment is even higher in the earlier years, when the existing labor force is small.

The efficient allocation of resources will require labor to be transferred from Egypt to Libya, and this transfer should be continued until labor productivity is equal in both economies. The process of equalization will be enhanced by capital transfer from Libya to Egypt. Since the capital productivity for Libya is low, capital should be allocated to Egypt until the marginal productivities of capital are equal in both economies.

The production possibility frontier for the integrated economy shows that the gains from integration will be an increase in GDP of 51 percent and 89 percent in Egypt and Libya, respectively.

The above conclusions depend on purely economic grounds, but it must be stressed that the decision for integration does not rest solely on economic considerations. There are other equally important political, religious, and social factors. In the author's opinion, gains or losses resulting from such factors are far more important in the

Arab world and may influence the decision of integration either way. Hence, allowance should be given to these factors in any attempt to establish any form of economic integration in the region.

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APPENDIX A

ESTIMATES OF MARGINAL PRODUCTIVITIES OF CAPITAL AND LABOR FOR EGYPT

Year	MPL Per Year	MPL Per Week	Per Day	Per Hour	MPK
1962	1347.99	26.96	3.84	.48	1.60
1963	1419.60	28.39	4.04	.51	1.40
1964	1472.23	29.44	4.19	.52	1.31
1965	1213.88	24.28	3.46	.43	1.27
1966	1239.49	24.79	3.53	.44	1.33
1967	1232.75	24.65	3.51	.44	1.55
1968	1242.15	24.84	3.54	.44	1.77
1969	1315.10	26.30	3.75	.47	1.73
1970	1454.22	29.09	4.14	.52	1.61
1971	1502.18	30.04	4.28	.54	1.67
1972	1493.43	29.87	4.26	.53	1.82
1973	1867.07	37.34	5.32	.67	1.71
1974	1633.45	32.67	4.65	.58	1.29
1975	1697.72	33.95	4.84	.61	.83
1976	1986.50	39.73	5.66	.71	.89
1977	2157.23	43.15	6.15	.77	.84

$R_3 = Q = 1.66 \log L + .224 \log K$

APPENDIX A

ESTIMATES OF MARGINAL PRODUCTIVITIES OF CAPITAL AND LABOR FOR EGYPT

Year	MPL Per Year	MPL Per Week	Per Day	Per Hour	MPK
1962	868.89	17.48	2.48	.31	2.17
1963	915.08	18.30	2.60	.32	1.91
1964	948.97	18.90	2.70	.34	1.79
1965	782.44	15.90	2.23	.28	1.72
1966	798.97	15.97	2.28	.29	1.82
1967	794.60	15.89	2.26	.28	2.15
1968	800.66	16.01	2.28	.285	2.42
1969	847.68	16.95	2.42	.30	2.35
1970	893.19	17.86	2.55	.32	2.19
1971	968.27	19.37	2.76	.35	2.31
1972	962.63	19.25	2.74	.34	2.47
1973	1203.47	24.07	3.42	.43	2.32
1974	1052.92	21.06	2.99	.38	1.75
1975	1094.51	21.89	3.12	.39	1.12
1976	1280.48	25.61	3.65	.46	1.21
1977	1390.50	27.80	3.96	.49	1.14

$R_4 = Q = .305 \log K + 1.07 \log L$

APPENDIX A

ESTIMATES OF MARGINAL PRODUCTIVITIES OF CAPITAL AND LABOR FOR EGYPT

Year	MPL Per Year	MPL Per Week	Per Day	Per Hour	MPK
1962	566.80	11.34	1.61	.20	2.62
1963	617.65	12.35	1.76	.22	2.31
1964	620.82	12.42	1.77	.22	2.16
1965	511.89	10.237	1.46	.18	2.03
1966	522.68	10.45	1.49	.19	2.19
1967	519.83	10.40	1.48	.19	2.55
1968	523.80	10.48	1.49	.19	2.91
1969	554.56	11.09	1.58	.20	2.84
1970	613.23	12.27	1.75	.22	2.64
1971	633.45	12.67	1.81	.23	2.78
1972	629.76	12.60	1.79	.22	2.98
1973	787.32	15.75	2.24	.28	2.80
1974	688.80	13.78	1.96	.25	2.12
1975	715.90	14.32	2.04	.25	1.35
1976	802.18	16.04	2.29	.29	1.46
1977	907.10	18.14	2.58	.32	1.37

APPENDIX A

ESTIMATES OF MARGINAL PRODUCTIVITIES OF CAPITAL AND LABOR FOR EGYPT

Year	MPL Per Year	MPL Per Day	MPL Per Hour	MPK
1962	189.60	.54	.07	.45
1963	223.34	.64	.08	.46
1964	233.57	.67	.08	.44
1965	226.24	.65	.081	.49
1966	224.35	.65	.07	.50
1967	218.67	.62	.07	.57
1968	212.78	.60	.07	.64
1969	220.50	.63	.08	.61
1970	239.07	.68	.09	.55
1971	231.29	.66	.082	.54
1972	230.7	.66	.082	.59
1973	250.77	.71	.090	.48
1974	266.12	.76	.095	.45
1975	311.64	.89	.11	.32
1976	325.50	.93	.12	.31
1977	346.50	.99	.12	.28

APPENDIX A

ESTIMATES OF MARGINAL PRODUCTIVITIES OF CAPITAL AND LABOR FOR LIBYA

Year	MPL Per Year	MPL Per Week	Per Day	Per Hour	MPK
1962	423.75	8.48	1.21	.15	2.59
1963	590.91	11.82	1.68	.21	3.31
1964	852.36	17.05	2.43	.30	3.42
1965	1168.72	23.37	3.33	.41	3.30
1966	1428.83	28.58	4.08	.51	3.31
1967	1600.82	32.02	4.56	.57	3.49
1968	2141.00	42.82	6.10	.76	3.64
1969	2317.19	46.34	6.60	.82	3.77
1970	2298.91	45.98	6.55	.82	5.87
1971	2456.68	49.37	7.03	.88	5.19
1972	2800.46	56.01	7.98	.99	3.87
1973	3488.95	69.78	9.94	1.24	3.25
1974	5526.31	110.53	15.74	1.97	3.86
1975	4715.07	94.30	13.43	1.68	3.18
1976	5829.83	116.60	16.61	2.08	4.05
1977	6506.43	130.13	18.54	2.32	3.98

$R_2 = Q = .24 \log L + .97 \log K$

APPENDIX A

ESTIMATES OF MARGINAL PRODUCTIVITIES OF CAPITAL AND LABOR FOR LIBYA

Year	MPL Per Year	MPL Per Week	Per Day	Per Hour	MPK
1962	1983.12	39.66	5.65	.71	1.87
1963	2765.45	55.31	7.89	.98	2.39
1964	3989.04	79.78	11.36	1.42	2.47
1965	5469.60	109.39	15.58	1.95	2.38
1966	5715.34	114.31	16.28	2.04	2.39
1967	7491.86	149.84	21.34	2.67	2.52
1968	10019.90	200.40	28.55	3.57	2.62
1969	10844.45	215.89	30.90	3.86	2.72
1970	10758.88	215.17	30.652	3.80	4.24
1971	11553.43	231.07	32.92	4.12	3.75
1972	13106.16	262.12	37.34	4.67	2.79
1973	16328.27	326.57	46.52	5.82	2.35
1974	25863.13	517.26	73.68	9.20	2.79
1975	22066.53	441.33	62.87	7.86	2.29
1976	27283.60	545.67	77.73	9.72	2.92
1977	30450.10	609.00	86.80	10.84	2.88

APPENDIX A

ESTIMATES OF MARGINAL PRODUCTIVITIES OF CAPITAL AND LABOR FOR

Year	MPL Per Year	MPL Per Week	Per Day	Per Hour	MPK
1962	3373.01	67.46	9.61	1.2	1.28
1963	4703.64	94.07	13.40	1.67	1.64
1964	6784.78	135.69	19.33	2.42	1.69
1965	9302.99	186.06	26.50	3.31	1.63
1966	11373.53	227.47	32.40	4.05	1.64
1967	12742.56	254.85	36.30	4.54	1.73
1968	17042.43	340.85	48.55	6.07	1.80
1969	18444.64	268.90	52.55	6.57	1.86
1970	18299.30	365.99	52.14	6.52	2.91
1971	19650.71	393.01	55.99	6.99	2.57
1972	22291.67	455.83	63.51	7.94	1.92
1973	27772.02	555.44	79.12	9.89	1.61
1974	39448.2	788.96	112.39	14.05	1.91
1975	25412.89	508.26	72.40	9.05	1.57
1976	46405.40	928.11	132.21	16.53	2.00
1977	51791.19	1035.82	147.55	18.40	1.97

$R_4 = Q = -7.3 + 1.99 \log L + .48 \log K$

APPENDIX A

ESTIMATES OF MARGINAL PRODUCTIVITIES OF CAPITAL AND LABOR FOR LIBYA

Year	MPL Per Year	MPL Per Day	MPL Per Hour	MPK
1962	721.18	2.068	.26	.68
1963	804.19	2.29	.29	.69
1964	1060.70	3.02	.38	.96
1965	1421.12	4.05	.51	.88
1966	1710.51	4.87	.61	.62
1967	1866.00	5.32	.67	.63
1968	2328.77	6.64	.83	.61
1969	2507.66	7.14	.89	.63
1970	1920.76	5.47	.68	.77
1971	2304.11	6.58	.82	.75
1972	3266.10	9.30	1.10	.69
1973	4692.00	13.37	1.67	.67
1974	6366.20	18.14	2.27	.69
1975	7184.82	20.47	2.56	.75
1976	7337.00	20.90	2.61	.79
1977	8354.30	23.82	2.98	.79

$RE_2 = Q = -3.8 + .70 \log K + 1.17 \log L$

APPENDIX B

In the case of Egypt and Libya, the convex shape of the isoquants could be derived as corollary to the assumption that the marginal productivity of an input is likely to be decreasing for increases in that input.

The production function is $Q = f(K,L)$, and both f_k and f_l are positive, that is, the marginal productivities are positive. We also showed the $f_{kk} < 0$ and $f_{ll} < 0$. In order to show that $d(MRS)/dl < 0$, we need to do the following. We have

$$MRS = f_l/f_k,$$

then

$$\frac{dMRS}{dL} = \frac{d(f_l/f_k)}{dL} .$$

Because f_l and f_k are functions of both K and L, we must take the total derivative of this expression:

$$\frac{d(MRS)}{dL} = [f_k(f_{ll} + f_{lk} \cdot \frac{dK}{dL}) - f_l(f_{kl} + f_{kk} \cdot \frac{dK}{dL})]/(f_k)^2.$$

Using the fact the $dK/dL....f_l/f_k$ along an isoquant, and the fact that $f_{kl} = f_{lk}$, we have

$$\frac{dMRS}{dL} = (f_k{}^2 f_{ll} = 2f_k f_l f_{kl} + f_l{}^2 f_{kk})/(f_k)^3.$$

Since $f_k > 0$, the denominator of this function is positive; hence the whole fraction will be negative, providing the numerator is negative. Because f_{ll} and f_{kk} are both negative, the numerator will

definitely be negative if f_{kl} is positive, which is the case for both economies. A positive f_{kl} means that an increase in L will increase MP_k, and vice versa.

APPENDIX C

PRODUCTION ELASTICITIES AND RATIO OF MARGINAL PRODUCT TO OPPORTUNITY COST FOR SELECTED CROSS-SECTIONAL PRODUCTION FUNCTION STUDIES

Location of sample	Type of Farming	Elasticity of production[a]				Ratio of Marginal product to opportunity cost			Reference
		Labor	Land	Other Services	Sum	Labor	Land	Other Services	
Guatemala	Mixed	.10	.77	.18	1.05	.51	5.5	1.25	
India	General arable land	.56	.08	.25	.89	NA	NA	NA	Sarker, 1957
Greece, Epirus	Mixed	.44	.10	.11	.65	.87	.90	.91	Yotopoulos, 1967
India, Utter Pradesh	Wheat, sugar cane	.43	.23	.35	1.01	.68	.95	2.13	Agrawal and Foreman, 1959
Taiwan Tainan	Cereals	.33	.44	.31	1.08	2.84	.58	.99	Wang, 1959
India, Andhra Pradesh	Mixed	.26	.14	.13	.53	.21	.05	.35	Agrawal and Foreman, 1959
Canada, Alberta	Wheat, beef	.20	.39	.34	.93	1.21	2.58	1.01	Darcovich, 1958

[a]For all functions, the elasticities are significantly different from zero at a probability level of 5 percent.

Source: Pan A. Yotopoulos, Allocative Efficiency and Economic Development (Athens: Center of Economic Planning, Research Monograph Series, 1967), p. 212.

APPENDIX D

The form of CES is

$$Y = \gamma[\delta K^{-\rho} + (1-\delta)^{-\rho} L^{-1/\rho}], \tag{1}$$

where γ is the efficiency parameter, δ is the distribution parameter ($0 \leq \delta < 1$), and ρ is the substitution parameter ($-1 < \rho < \infty$). Assuming perfect competition and profit maximization from equation 1, we can obtain

$$\sigma = \frac{d\frac{(K)}{(L)} P_1 L}{d\frac{(P_1)}{(P_k)} P_k K} . \tag{2}$$

Note that

$$d\frac{(K)}{(L)} / d\frac{(P_1)}{(P_k)} > 0.$$

Furthermore, the marginal rate of substitution, R, is equal to

$$R = \frac{\frac{\partial Y}{\partial K}}{\frac{\partial Y}{\partial L}} = \frac{\partial L}{\partial K} = \frac{\delta}{1-\delta} \frac{(L)^{1+\rho}}{(K)} = \frac{P_k}{P_1} : \tag{3}$$

Dividing both sides by L/K,

$$\frac{P_k K}{P_1 L} = \frac{(\delta)}{(1-\delta)} \frac{(L)^{\rho}}{(K)} .$$

If $\sigma > 1$ ($\rho < 0$) and the relative price ratio, P_k/P_1, falls by one percent, L/K will fall more than one percent; therefore, $P_k K/P_1 L$ will increase. That is, the share of K will increase and the share of L will decrease. If $\sigma < 1$ and P_k/P_1 falls by one percent, L/K will fall by less than one percent and, consequently, P_k/P_1 will rise. When

$\sigma=1$, the share of the factor whose price has risen will increase when $\sigma<1$ and will decrease when $\sigma>1$.