ALTERNATIVE COSTS AND TOTAL ECONOMIC BENEFITS: AN INPUT - OUTPUT STUDY OF THE ASWAN DAM (EGYPT)

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A Dissertation Presented

by

Mohamed E. Abdel Rahman

to

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ALTERNATIVE COSTS AND TOTAL ECONOMIC BENEFITS: AN INPUT - OUTPUT STUDY OF THE ASWAN DAM (EGYPT).

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ABSTRACT OF DISSERTATION

Submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Economics in the Graduate School of Arts and Sciences of Northeastern University, July 1980.

ABSTRACT

This study empirically assesses the alternative costs and total (direct and indirect) economic benefits of the Aswan Dam to the Egyptian economy. The chief analytical tool is a static version of Leontief's Input-Output model. Changes in the structure of the Aswan Region's economy during the construction of the Dam are also estimated, using various methods of regional economic analysis such as location theory and shift-share.

The alternative costs are the net drain on the economy of using other methods to produce an amount equal in value to the electrical power and agricultural output made possible by the water supply of the Dam. The estimated alternative costs show the Dam to be a very efficient source of electric power and of water for irrigating additional land and hence to be economically justified in these terms alone.

The total benefits encompass the expected increase in the demand for the Dam's extra electric power and agricultural production. The demand for the Dam's hydroelectric power is intermediate. Thus, the total benefits from the additional electricity can be analyzed in terms of the increases in domestic sector's output, employment, and contribution to the balance of payments position of the country. The actual magnitude of these benefits depend

on which of two growth strategies is considered; one assumes balanced growth and the other unbalanced. In the balanced growth strategy, the additional electricity is distributed among all sectors of the economy in proportion to their contribution to total final demand, whereas in the unbalanced growth strategy, sectors with large growth potential are given preferential treatments. Therefore, the latter strategy first requires the identification of key sectors measured on the basis of the strength of their forward or backward linkages to other domestic sectors. The linkages are calculated from the inverse of the technical coefficients matrix of the 1971 Egyptian Input-Output table.

It can be shown that total benefits to the national economy are greater under the unbalanced growth than the balanced growth strategy.

Most of the farm output is consumed by the household sector as final demand. The main direct benefits of this extra agricultural output are: gains in farm income; the reductions in the size of the surplus labor force and narrowing of income differentials within the agricultural sector. The indirect benefits are felt primarily in terms of the generation of additional income and the stimulation of new employment in the chemical, transportation and service sectors. These indirect benefits are measured by using the agricultural sector income and employment multipliers.

A significant regional result of the construction expenditures on the Dam is the short run improvement in the comparative advantage of the Aswan Region's raw-materials oriented industries. These industries are found to possess strong linkages with the rest of the region's economy. This finding suggests that additional investment in these industries may improve their long run comparative advantage and lead to the creation of a regional growth pole.

National policy implications of the study are that the Aswan Dam is the basis for future economic development in Egypt. If the maximum benefits of its electric power are to be realized, Egypt's development policy should emphasize the allocation of the country's limited investment funds to the creation and/or expansion of a "growth industry" in each of the economy's key processing sectors with the strongest forward linkages. These sectors are found to be: chemicals; food processing; spinning and weaving; iron and steel. Moreover, two other key primary sectors should continue to be developed, namely transportation and agriculture. The latter will continue to be the dominant sector of the Egyptian economy, because of its labor absorptive capacity, its production of foodstuffs, and its role as a source of intermediate inputs to agro-based industries which generate over half of all exports under each of the two development strategies examined.

ACKNOWLEDGEMENTS

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M.A.R.

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CHAPTER I

INTRODUCTION

In this chapter, we state the problem, purpose and scope of the study, present the methodology to be used, and outline the overall organization of the dissertation.

(1) Statement of the Problem

A major undertaking, such as the construction of the multipurpose Aswan High Dam project, significantly alters the infra-structure of the national economy and the region in which the project is located. The impacts of such large projects are diverse and can be widely felt. The problem is how to measure the economic benefits, broadly defined, of a project with multiple objectives whose impacts are both immediate and long run and will affect many sectors of the economy unevenly.

The primary and immediate impacts of the Aswan High Dam is a larger and steadier flow of water, which will make possible the irrigation of additional farm land, a change in crop patterns, and generation of hydro-electric power at a relatively low cost. However, it has been increasingly recognized that the effectiveness of such large investments lies not only in their direct products, but also in their indirect repercussions on the national and regional economies.[1] In developing

1. Albert O. Hirschman, Development Projects Observed. (Washington: the Brookings Institute, 1967), p. 196.

nations, these indirect effects are realized primarily through forward technological links with other sectors. Due to the underemployment of resources, these indirect effects cause a net addition to national income. Failure to take these effects into consideration results in an underestimation of the impact of such projects on economic development.

However, measuring projects' total impact is a difficult task both technically as well as economically.[2] The technical consequences of a project will often be of an engineering or a geological character. In the case of the Aswan High Dam, there is sedimentation and erosion of the river bed downstream as well as water losses from reservoir seepage and evaporation. In addition there are environmental and social problems that are not easy to quantify. One example is the social cost of the forced resettlement of 55,000 Nubians whose land was flooded in the course of the Dam's construction. A more conjectural example is the social benefits from the possible increase in rain fall in the dry climate of Upper Egypt.[3]

Limiting ourself to the economic aspects alone does not simplify the problem of evaluation. Some

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2. Jan Tinbergen, Economic Policy: Principles and Design. Amsterdam: North Holland Publishing Co., 1965), pp. 178-180.
3. For more discussion about the environmental impacts of Aswan High Dam, see John Waterbury, Egypt: Burdens of the Past, Options for the Future. (Bloomington, Indiana: Indiana University Press, 1978), pp. 103-108.

economists argue that the total impact of large scale development projects can be determined by comparing two well defined development paths of the economy, one in which there is no project, and the other where there is.[4] This approach, sometimes referred to as one "with and without principle,"[5] cannot be applied very precisely, since Egypt, like most other developing countries, lacks the necessary statistics. Even if the required data are available, and there is the possibility of deriving an exact relationship between the project and the rest of the economy from an econometric model, differences of opinion will remain whether actual economic events occurring in the future are or are not due to the project as the model predicts.[6]

As for regional spread effects, economists believe that the investment expenditures for the construction of infra-structure projects will stimulate development of the socio-economic structure of the regions in which they are located. Unfortunately, the experience of under-developed areas over the past twenty five years does not confirm this.[7] Once a project is completed, it may become

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4. Tinbergen, op. cit., p. 180.
5. See Otto Eckstein, Water Resource Development. (Cambridge, MASS.: Harvard University Press, 1958), p. 51-52.
6. Tinbergen, op. cit., p. 180.
7. For example, the Tenessee Valley Authority (TVA), whose purpose was similar to that of the Aswan Dam, proved to be failure in its inability to stimulate

just a "cathedral in the desert" because there is no guarantee that the heightened economic activity of the construction period will continue.

(2) Purpose of the Study

The present work is an empirical study of the Aswan High Dam project. The main objective is to simplify the problem of evaluating the economic consequences, both direct and indirect, of the project for economic development. This is done by resorting to an input-output model to estimate first, the alternative costs of the primary outcomes of the Dam, and second their total benefits (direct and indirect). The first is measured by the net drain on the national economy if traditional methods are used to supply the same outcomes. The second is measured by the induced changes in the net output of domestic sectors; in employment and in foreign earnings. These induced changes themselves reflect the nature of demand for the primary products of the Dam. The study also will explore changes in the

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regional economic growth. Industrialization did not automatically follow the availability of low cost electricity; local unemployment rates continued to be higher than the national average. See John Moore, ed., The Economic Impacts of TVA. (Knoxville, Tenn.: University of Tennessee Press, 1967), p. 128. Also, the construction of petroleum refineries and chemical plants in geographically isolated part of southern Italy yielded minimal polarization and a scant multiplier effect. See Niles M. Hanson, "Development Pole Theory in Regional Context", in David L. McKee, Robert D. Dean and William H. Leahy, eds., Regional Economics: Theory and Practice. (New York: The Free Press, 1970), p. 131.

structure of the Aswan region's economy, and ascertain whether or not these changes will help realize its economic potential.

(3) Scope and Limitations of the Study

The study concentrates on the two most important primary products of the Dam, and on its regional economic effects. These two products are hydroelectric power and the net increase in agricultural output, both due to the enhanced and steadier supply of water. Our regional analysis is limted to the Dam's spread effects during its construction, in the Aswan region, recognizing that other regions might also be affected. Our study is confined to the period ending in 1974 because of the lack of reliable data afterwards. No attempt is made to predict long term developments. Moreover, possible political, social, cultural, and environmental consequences are not explored. Most are not amenable to economic analysis.

(4) Methodology

Input-output analysis is especially suited to analyzing both alternative costs and benefits of the Dam. The alternative costs are measured in terms of the resources that would have been needed to satisfy a given final demand equal in real terms to the primary products of the Dam. The second is concerned with both the direct and indirect benefits to the overall economy.

The effects of the Dam are determined by comparing them under two developmental strategies, one assumes balanced growth and the other unbalanced growth. The former strategy assumes that the Dam's electrical power is allocated among all sectors in proportion to their contribution to final demand. The second assumes that the power is allocated on the basis of the strength of linkages among sectors. These linkages identify which sectors are important to development. Input-output analysis is needed to determine such linkages. Also, through our input-output model, it is possible to compute a set of consistent sectoral output levels needed to satisfy this demand. The interflow matrix of the 1971 input-output table of the Ministry of Planning, the most recent available such table, has been inverted and used for this purpose.

The following hypotheses will be tested:

a) The cost to the national economy of producing the Dam's primary outputs will be much greater if traditional methods are used.

b) Gains to the national economy can be maximized if the electrical power from the Dam is directed toward key sectors, i.e., those which are vital to the expansion of the overall economy.

c) Construction expenditures in Aswan for the Dam will improve the comparative advantage of the region's basic industries; these industries might provide the core of a growth pole if they have strong linkages to other sectors in the region.

(5) Organization of the Dissertation

Chapter 2 critically reviews criteria used by other studies evaluating the Aswan Dam project. It is argued that the limitations of these studies justify our use of an input-output model. Chapter 3 presents the theoretical framework for the empirical analysis of the next two chapters. In the chapter, Leontief's open static Input-Output model is used for three purposes: (1) to estimate the alternative costs of traditional ways of producing the Dam's primary products (electrical power and water for irrigation); (2) to identify key sectors of the Egyptian economy in order to estimate the total benefits of the additional hydroelectric power; and (3) to derive income and employment multipliers in order to estimate the benefits of the net agricultural output due to the additional water supply from the Dam.

Chapter 4 represents the first part of the empirical application of the model. This chapter measures the value of the electrical power and net agricultural output attributable to the Dam, as well as their alternative costs.

Chapter 5 analyzes the importance of these direct benefits for economic development and industrialization in Egypt. First, sectoral linkages are identified by computing indices of interdependence. Next, the total benefits from the additional hydroelectric power are estimated in terms of two growth strategies, i.e., balanced and unbalanced. Finally, the benefits from the net agricultural output are calculated by using the income and employment multipliers.

Chapter 6 examines the economic effects of the Dam on the Aswan Region itself. These effects include changes in population, employment, urbanization, per capita income, migration, attractiveness to industry, and future growth potential. The final chapter summarizes the basic thesis and makes policy recommendations.

CHAPTER II

PRIOR STUDIES OF THE ECONOMIC IMPACT OF THE ASWAN DAM

The purpose of this dissertation as stated in the first chapter, is to apply the input-output technique to estimate empirically the alternative costs and the benefits (direct and indirect) of the Aswan Dam project to the Egyptian economy. In this chapter, we briefly review three other techniques that have been used to evaluate the economic efficiency of the project. The three techniques are: benefit-cost analysis, consumer and producer surplus, and linear programming. We summarize the main empirical findings of these studies and critically analyze them. We will show the limitations of these studies and will justify the adoption of the input-output analysis instead.

(1) Benefit-Cost Analysis

Benefit-cost analysis justifies the economic feasibility of an investment project when its discounted benefits exceed its discounted costs over its life span. Benefit-cost ratio is then used as a policy guide to rank and select alternative projects; projects with the higher ratios are inevitably regarded as more efficient and preferable to those with lower ratios.[1]

1. Roland N. McKean, Efficiency in Government Through System Analysis: With Emphasis on Water Resources Development. (New York: John Wiley and Sons, 1967), pp. 103-133.

Two different studies made use of this technique in evaluating the economic efficiency of the Aswan Dam project. The first is a study by the National Bank of Egypt in 1964[2], which was based on the assumption that the total cost of the project could be allocated among hydroelectric power generation and agricultural uses. The study also assumed that water projects are characterized by low risk and long life expectancy, the cut-off point of the effect for the project was set at 75 years. The discount rate of 10 percent was then used instead of the market interest rate of 7 percent. This higher rate was chosen to adjust for the risk of the power plant due to technological changes. The study estimated benefit-cost ratio for hydroelectric and agricultural purposes to be 7.6 and 2.0 respectively. In addition, the study introduced arbitrary figures to account for additional cost and benefit elements, such as, gains from improving river navigation, and the costs of preserving ancient monuments. An overall benefit-cost ratio was then estimated at 3.1. The study concluded that these ratios were high in comparison with benefit-cost ratios of similar projects in the United States.[3]

2. National Bank of Egypt, "The Benefit-Cost Analysis of the High Dam - A Case Study on the Economics of Water Project Evaluation", Economic Bulletin, Vol. 18, 1965, pp. 266-277.
3. Ibid., p. 276.

A more recent study (1971) sought to apply three different investment criteria for the Aswan Dam project. One was the benefit-cost ratio, the two others were present value and internal rate of return.[4] The study assigned 50 years for the life expectancy and used three different rates of discount, a lower limit of 6 percent representing interest rate on government bonds maturing in 20 years, an upper limit of 15 percent representing rate of return on investment in the private industrial sector in 1960 and a intermediate rate of 10 percent. Although this study considered only direct benefits and costs, its main contribution was to adjust official estimates of both direct costs and benefits streams and to introduce uncertainty in the project's results. The actual cost of the project was adjusted upward to account for: interest on funds; the increase in the cost of reclaiming new cultivable land due to the expected inflationary wages; poor soil quality; and the cost of using chemical fertilizers as a substitute for the loss of natural silt derived from the river during its flood season. The main finding was that although the present value and benefit-cost ratio of the project were highly sensitive to changes in the discount rates applied, the project was still economically justifiable with a 15

4. Yusuf Shibl, "The Aswan High Dam: Benefit and Cost Analysis", unpublished Ph.D. dessertation, University of California, Los Angeles, 1971.

percent discount rate. However, if full benefits of the Dam's hydraulic station and reclamation on the maximum expected cultivable land were not realized by 1976, and the total water losses exceeded 10 billion cubic meters annually, the project would yield a negative present value at 15 percent discount rate.

(2) Consumer and Producer Surplus

In a study applied for the Aswan Dam, only the economic efficiency of the agricultural portions of the project were examined.[5] The total agricultural gains were measured by the maximum amount which the consumers of these farm products would be willing to pay for them. This technique overcame one serious criticism of benefit-cost analysis, namely, the use of market prices to estimate benefits and costs. The study estimated new domestic supply and demand equations and equilibrium prices for farm products as a result of the project. This analysis was done for each year over the period 1960 through 1977. The amounts by which the two curves shifted represented the total gains from the project in terms of consumer's and producer's surplus. These gains were then discounted at 3 and 6 percent. The lower rate was the interest charge on the Russian loan used to build the Dam; the higher rate, interest charges

5. Abdel-Fattah Kandeel, "The 'Surplus' Approach for Project Appraisal: An Application to the Aswan High Dam", unpublished Ph.D. dissertation, University of Southern California, Los Angeles, 1966.

on the International Bank for Reconstruction and Development loans for similar infra-structure projects at that time.

The main empirical findings of the study are summarized below:

Net Gains of the Agricultural Aspects of the Aswan Dam Project (Million Egyptian Pounds)

	Discounted at 3 percent	Discounted at 6 percent
Total surplus	$ 517,567	430,260
Agricultural share of total cost of the project	363,200	343,520
Net gains	154,367	86,740

Since the discounted consumer's and producer's surplus from the project exceeded the discount relevant costs, the study concluded that agricultural aspects of the project were economically sound. These findings depended on two crucial assumptions. First, increase in national income from expenditures on the Dam's construction was the main shift variable in estimating the successive demand equations. The increase in national income comes through expenditures of LE 20 million (Egytian pounds) for each of the ten years and expenditure multiplier of 5.7, based upon an assumed marginal propensity to consume (MPC) of 0.826. Second, the increase in the amount of cultivable land due to the additional supply of water was the main shift variable in estimating the supply equations. The annual additions were 100,000 Feddans (1 Feddan = 1.038 acres) for each of 13 successive years, in order to achieve official government targets.

(3) Linear Programming

Again, in the application of linear programming to the Aswan Dam, the agricultural results alone of the project were also evaluated. The main purpose was to determine the gains and losses of alternative optimum land-utilization patterns, for 1970 and 1975.[6] The study attempted to correct the inadequacy of using market prices to evaluate scarce project inputs, namely, labor and foreign exchange. The objective function to be maximized was the net profit accruing to farmers and to the economy as a whole. The basic constraints were land and the water available for the expansion of the agricultural sector. There also was a minimum employment constraint. This was the increase in annual work opportunities to be provided by the farm sector.

Optimum land-utilization patterns were determined for two different kinds of economies, an open one, and one with different degrees of self-sufficiency. In the open economy, agriculture concentrated on the production of rice and cotton, in which Egypt has a comparative

6. Walid C. Niazy, "The Economics of Public Projects in Less Developed Countries: A Case Study of the Aswan Dam", unpublished Ph.D. dissertation, University of Pennyslvania, 1971.

advantage in foreign trade. In the second example, more land was allocated to grains, particularly maize and wheat. Both were considered by the study to be the important staples consumed in Egpyt, but their production could be assured only by government determining minimum amounts of land to be used. The production of grains was to equal 86-88 percent of total domestic needs. The study recommended to the Egyptian government a policy of specialization in producing rice and cotton, if the full potential agricultural benefits of the project were to be reaped.

(4) Critical Analysis of These Studies

The two studies using benefit-cost criteria to evaluate the Dam, treated the Dam as if it were a private investment project. They implicitly assumed that the main objective was to maximize profits. This approach assumes that perfectly competitive markets exist with no production externalities.[7] If such market structures prevail, supply and demand conditions, as well as market prices, are considered to be "hard information" and the latter can be used to measure earnings and costs. However, market prices become "soft" and their use in evaluating projects and other allocative purposes is

7. United Nations, Guidelines for Project Evaluation, Project Formulation and Evaluation Series, No. 2, New York, 1972, Chapter 2.

unwarranted, especially when there are abundant supplies of some productive resources and shortage of others, as is characteristic of developing nations.[8]

Social benefit-cost analysis offers a sounder way of determining the economic efficiency of infra-structure projects. In this respect, projects can be examined in terms of their contribution to an appropriate set of national objectives. These objectives can include net national output, consumption, employment and foreign exchange.[9]

A project's contribution to net national output is represented by the additional amounts of goods and services made available to the economy as a result. These products may represent additions to an existing supply, or substitutes for it. In the latter case, a project's contribution can be measured by the additional resources made available by the discontinued use of the former ones.

Aggregate consumption benefits are the future consumption flows made possible by the project. They can be calculated in terms of the present values of future consumer surpluses, using an appropriate social discount rate. The possibility of finding a social discount rate that correctly represents future time preferences in order

8. Ibid., p. 12.
9. Ibid., Chapter 3.

to indicate when resources should be transferred from one sector to another is difficult, because little can be known about internal investment opportunities in the distant future.[10]

An increase in employment can also be taken as a separate objective in infra-structure projects. Here it is important to determine whether the project relied upon unemployed workers or drained employed workers from other sectors. Many developing countries suffer from chronic shortages of savings and foreign exchange, therefore, projects should be examined in terms of their contribution to the production of export goods or to import substitutes. In either case, the net effect on foreign exchange is the extent to which exports are increased or imports decreased.

Another criticism of benefit-cost is its failure to account for the indirect impacts of infra-structure projects on other productive sectors of the economy. These secondary impacts alter the production possibilities of other sectors, in particular those which benefit the most from the project.[11]

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10. See for example: Ian M. Little and James A. Mirrless, Manual of Industrial Project Analysis in Developing Countries, Vol. II, Cost Benefit Analysis. (Paris: OECD, 1968), p. 33; J. Tinbergen, Central Planning. (New Haven: Yale University Press, 1964), p. 29; McKean, op. cit., p. 118; United Nations, Guidelines for Project Evaluation, op. cit., p. 160.
11. McKean, op. cit., p. 136.

The study evaluating the Dam on the basis of consumer's and producer's surplus and the one employing linear programming considered only the agricultural aspects of the project. Both neglected the interdependence of the agricultural and nonagricultural costs and benefits of the Dam. It is widely accepted by economists that there are investment indivisibilities in large scale multipurpose projects.[12] For example, the Dam's water supply serves various functions. In allocating the project's total cost among different purposes, it is safe to assign the expenditure on electric generating equipment to the hydroelectric purposes of the project, and the cost of reclaiming new land or expenditures on irrigation pump facilities to its agricultural purposes. However, it is impossible to assign parts of the joint investment in the Dam and its reservior among different uses, because both are necessary for achieving each purpose.[13] Allocation of joint investment assumes that it is possible to add or remove portions of the Dam and reservoir without impinging on more than one purpose.[14] The allocation of joint costs among different purposes

12. John V. Krutilla and Otto Eckstein, Multiple Purpose River Development, Studies in Applied Economic Analysis. (Baltimore, MD.: John Hopkins Press, 1958), p. 67.
13. Otto Eckstein, Water-Resource Development: The Economics of Project Evaluation. (Cambridge, Mass.: Harvard University Press, 1968), p. 262.
14. McKean, op. cit., pp. 137-138.

usually is arbitrary and the resulting benefit-cost ratios equally arbitrary.[15] Even if we assume that the allocation of joint costs can be done properly, the same problem exists in estimating joint benefits. The interdependence among sectors makes it unrealistic to treat each independently. This approach might be acceptable in a case where one sector is relatively small or relatively independent. In most developing countries agriculture and other sectors are interdependent.

None of the studies took account of the regional economic impacts of the project. Only its effects on the national economy were considered. Yet, in the case of infra-structure projects, regional economic development is considered to be an important policy objective.[16] It is expected that large infra-structure projects such as the Aswan Dam will act as a growth pole and lead to the development of processing and service sectors that complement the project.

In addition, both the induced and the indirect benefits of the project during its gestation period can be expected to be realized primarily within the region rather than throughout the country as a whole. The construction expenditure made a large contribution to regional employment

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15. Eckstein, op. cit., p. 262.
16. Ibid., p. 263; also, United Nations, op. cit., p. 80.

and income. The increase in purchasing power of local residents will induce development of enterprises supplying a wide range of consumer goods and services. These activities in turn will induce further activities through the spending multiplier. Finally, the increase in spending on government services in the region due to the Dam may help stabilize the local economy. For these reasons, the impact of the project on the regional economy must be carefully analyzed.

Among the methods for measuring the regional impacts of infra-structure projects is one developed by M.E. Marts.[17] Marts' technique was used to estimate the direct and indirect benefits of an irrigation project to a town whose economy depended almost exclusively upon it. The study used increases in net farm income (derived from budget analyses) and the increase in total employment as measures of direct benefits. Indirect benefits were measured by increases in nonfarm (business and property) income. Marts found that local indirect benefits generated by the project were 1.27 times as large as direct. Input-output is another method that has been used to determine local developmental impacts, in particular of water resource projects. This technique was used by Canion and Trock to measure the relationship between the water supply

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17. Eckstein, op. cit., pp. 213-214.

from a local Dam and reservoir and the development of the economic sectors of five Texas counties.[18] The study also sought to determine how the additional water supply would affect the overall level of economic activity in these counties. The study used coefficients from 1958 National Input-Output Table and attempted to adjust them with local data on industry and product mix. An overwhelming obstacle in using this technique for the Aswan region is the lack of sufficient and reliable local data. Moreover, use of national coefficients and vector of sectoral regional outputs to construct a regional input-output table is valid only if the regional product mix and level of technology is the same as the national.[19]

Summary:

It is evident from our discussion that these studies showed little consideration to such important national objectives as net output, aggregate consumption employment and foreign exchange. Also, no attention was given to the indirect benefits resulting from the interrelationships between electric power generation and the rest of the economy. The studies that limited themselves

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18. Robert L. Canion and Warren L. Trock, "Input-Output as a Method of Evaluation of the Economic Impact of Water Resource Development", Technical Report, No. 12, Water Resource Institute, Texas A&M University, 1968, pp. 6-8.
19. William H. Miernyk, The Elements of Input-Output Analysis. (New York: Random House, 1965), pp. 66-68.

to the agricultural impacts were based on a highly controversial assumption, namely, the possibility of distributing benefits and allocating cost among the different purposes of the project. These studies also neglected the regional economic impacts, which themselves are important policy objectives, especially in economically depressed regions such as the Aswan region. These various limitations are critical enough to justify resorting to the input-output model. It avoids most of these, and has the special advantage of considering the interdependence of different sectors of the economy. This technique offers a superior way of measuring the project's alternative costs and total (direct and indirect) benefits. The latter can be used to show the nature of the economic development anticipated by the project.

CHAPTER III

THEORETICAL FRAMEWORK

The analysis of Chapter 2 has demonstrated that none of the criteria used in the evaluation of the Aswan High Dam project had considered the cost of alternative sources of providing comparable levels of its electric power and agricultural products. Also, no attention was given to how the availability of these two products would affect the economy through interdependency with other productive sectors. In this chapter, we will develop a model that will be used in estimating the Dam's alternative cost and total benefits (direct and indirect) to the national economy.

Alternative cost is measured by the net drain that will be imposed on the national economy by using other methods of producing output levels equal in value to those from the Dam. Total benefits are measured by the additional output, employment and net foreign earnings made possible by the availability of the Dam's electrical power and contribution to agricultural output.

The model we are presenting here is basically an extension of the ordinary open-static input-output model developed by Leontief. Therefore a complete and detailed exposition of its basic assumptions or limitations may not be necessary. Most of these have been dealt with in the input-output literature.[1]

Section 1 of this chapter presents our input-output model along with a discussion of the technical coefficient matrix and its inverse. Section 2 discusses the technique of estimating alternative costs in terms of required domestic resources, noncompetitive imports and labor. Section 3 expands the model as to enable us to estimate total (direct and indirect) benefits of the Dam to the Egyptian economy.

(1) The Input-Output Model

The essence of an input-output model is that activity of individual sectors of an economy are interrelated. In our model, we differentiate between key and nonessential sectors. Thus, the economy consists of n producing sectors, of which $i = 1,\ldots,s$ are nonessential sectors, while $i = s+1,\ldots,n$ are key sectors. The interindustry transactions of our n sector model can be summarized in value terms as follows:

1. For an analytical discussion of the theoretical foundations and the basic assumptions of the input-output model, see for example, Wassily Leontief, Input-Output Economics. (New York: Oxford University Press, 1966), Chapter 7; Hollis M. Chenery and Paul Clark, Interindustry Economics. (New York: John Wiley and Sons, 1967), Chapter 2; and P.N. Rasmussen, Studies in Inter-Sectoral Relations. (Amsterdam: North Holland Publishing Co., 1957).

$$(1)\quad \begin{bmatrix} x_1 \\ \vdots \\ x_s \\ \vdots \\ x_n \end{bmatrix} = \begin{bmatrix} X_{11} \cdots X_{1s} \cdots X_{1n} \\ \vdots \\ X_{s1} \cdots X_{ss} \cdots X_{sn} \\ \vdots \\ X_{n1} \cdots X_{ns} \cdots X_{nn} \end{bmatrix} + \begin{bmatrix} d_1 \\ \vdots \\ d_s \\ \vdots \\ d_n \end{bmatrix}$$

$$\begin{matrix} M_1 & M_s & M_n \\ V_1 & V_s & V_n \end{matrix}$$

where x_i is gross output of sector i; X_{ij} is output of sector i sold to sector j; d_i is final demand for products of sector i; M_j is intermediate imports of sector j; V_j is value added (payments to primary factor inputs) of sector j. These values can be expressed in terms of per dollar of output, where $a_{ij} = (X_{ij}/x_j)$, referred to as the technical coefficients, represents an estimate of the direct inputs requirements of sector i by sector j per dollar of j's output. Similarly, the value added coefficients $v_j = (V_j/x_j)$ and the import coefficients $m_j = (M_j/x_j)$.

Equation (1) can be expressed in terms of these coefficients as follows:

$$(2)\quad \begin{bmatrix} x_1 \\ \vdots \\ x_s \\ \vdots \\ x_n \end{bmatrix} = \begin{bmatrix} a_{11} \cdots a_{1s} \cdots a_{1n} \\ \vdots \\ a_{s1} \cdots a_{ss} \cdots a_{sn} \\ \vdots \\ a_{n1} \cdots a_{ns} \cdots a_{nn} \end{bmatrix} \begin{bmatrix} x_1 \\ \vdots \\ x_s \\ \vdots \\ x_n \end{bmatrix} + \begin{bmatrix} d_1 \\ \vdots \\ d_s \\ \vdots \\ d_n \end{bmatrix}$$

or $$x_i = \sum_{j=1}^{n} a_{ij}x_j + d_i$$

In matrix and vector notation, equation (2) may be expressed more compactly as:

(2') $$x = Ax + d$$

where x and d are column vectors of x_i and d_i respectively, and A refers to the technical coefficients matrix of a_{ij}'s. According to the Hawkins-Simons condition of macroeconomic stability, each a_{ij} must be less than one. If any element $a_{ij} > 1$ for $i \neq j$, the series of binominal expansion will not converge, and the elements of the inverse matrix $(I-A)^{-1}$ in equation (3) below will not assume finite values. If $a_{ij} = 1$ for $i = j$, all output of the sector is consumed directly in its production and no output is left for final demand. The case is even worse if $a_{ij} > 1$ for $i = j$, then more inputs are consumed than output produced.[2]

From equation (2'), the general solution of the model is as follows:

(3) $$\begin{bmatrix} x_1 \\ \vdots \\ x_s \\ \vdots \\ x_n \end{bmatrix} = \begin{bmatrix} z_{11} \cdots z_{1s} \cdots z_{1n} \\ \vdots \\ z_{s1} \cdots z_{ss} \cdots z_{sn} \\ \vdots \\ z_{n1} \cdots z_{ns} \cdots z_{nn} \end{bmatrix} \begin{bmatrix} d_1 \\ \\ d_s \\ \\ d_n \end{bmatrix}$$

2. Chiou-Shuang Yan, Introduction to Input-Output Economics. (New York: Holt, Rinehart and Winston, Inc., 1969), Chapter 3 and 6.

or

$$(3') \qquad x_i = (I - A)^{-1} d = Zd$$

where $Z = (I-A)^{-1}$ is the (n.n) matrix of z_{ij}. Any element z_{ij} in the Z matrix measures total (direct and indirect) inputs from sector i used by sector j to produce one dollar's worth of output of sector j for final demand. Elements in the Z matrix can be approximated by the following series

$$(4) \qquad (I - A)^{-1} = I + A + A^2 + A^3 + \ldots + A^n .$$

This approximates the total (direct and indirect) output required to satisfy final demand. The first term I accounts for the one dollar of output to be delivered to final demand by a given sector. The second term A indicates the direct input required to produce this one dollar of final demand. The successive A's measure the successive rounds of indirect inputs required to produce the direct input A. The elements of the Z matrix becomes:

$$(5a) \qquad z_{ij} = a_{ij} + \bar{a}_{ij} \qquad \text{for } j \neq i, \text{ and}$$

$$(5b) \qquad z_{ij} = 1 + a_{ij} + \bar{a}_{ij} \text{ for } j = i$$

where $\bar{a}_{ij}$ in (5a) represents the sum of all indirect inputs from sector i to sector j per one dollar of sector j's output, and where $\bar{a}_{ij}$ in (5b) represents an estimate of indirect input required from within the same sector to produce one dollar of output. If all the output produced by sector i is used directly and/or indirectly to produce sector i's output, nothing will be left for final demand. Therefore, for any sector to be able to produce for final demand, $z_{ij} > 1$ for all i = j.

(2) Estimation of Alternative Costs

This section discusses the three components of alternative costs, required domestic resources, labor inputs and imports.

(i) Required Domestic Resources

When there are other modes of providing the same service or output as the Dam, alternative cost is taken to be the resources required by the traditional mode to produce a comparable amount of output. In other words, we are answering the question: suppose the Egyptian government had chosen a traditional way to supply the same amounts of output; what amount of resources would be needed? An estimate of this alternative cost can be obtained by using the input-output model presented in the previous chapter.

To illustrate how this model can be applied, let 1 be the subscript for the electrical power sector.[3] All things equal, if sufficient demand for electric power exists, d_1 will increase by an equal amount of the net value of the electric power currently supplied by the

3. This is sector 24 in the 1971 Input-Output table used in this study.

Dam. To satisfy this final demand, all domestic sectors have to readjust their output, either by increasing or reallocating it. Total required resources are measured by the output of domestic sectors needed to meet this final demand, and can be estimated as follows:

$$(6)\quad \begin{bmatrix} \Delta x_1 \\ \vdots \\ \Delta x_s \\ \vdots \\ \Delta x_n \end{bmatrix} = \begin{bmatrix} z_{11} \cdots z_{1s} \cdots z_{1n} \\ \vdots \\ z_{s1} \cdots z_{ss} \cdots z_{sn} \\ \vdots \\ z_{n1} \cdots z_{ns} \cdots z_{nn} \end{bmatrix} \begin{bmatrix} \Delta d_1 \\ \vdots \\ 0 \\ \vdots \\ 0 \end{bmatrix} = \begin{bmatrix} z_{11}\Delta d_1 \\ \vdots \\ z_{s1}\Delta d_1 \\ \vdots \\ z_{n1}\Delta d_1 \end{bmatrix}$$

or

$$(6')\quad \sum_{i=1}^{n} \Delta x_i = \sum_{i=1}^{n} z_{i1}\, \Delta d_1 \ .$$

This is an estimate of the gross output due to Δd_1. This gross output includes the intermediate domestic inputs required to satisfy Δd_1 thus overstating the alternative costs because intermediate inputs are double counted. Net output rather than gross avoids double counting. The value added coefficients are used to calculate alternative cost in terms of the net output required by all sectors as follows:

$$(7)\quad \sum_{j=1}^{n} \Delta V_j = \sum_{j=1}^{n} z_{j1}\, v_j\, \Delta d_1$$

or

$$(7')\quad \sum_{j=1}^{n} \Delta V_j = \sum_{j=1}^{n} \Delta x_j\, v_j$$

because $\Delta x_j = z_{j1}\Delta d_1$.

(ii) Required Labor

A fixed proportions production function is one of the basic assumptions of an input-output model. Accordingly, labor inputs have a linear relationship to output. Once the production levels corresponding to an increase in d_1 are known from equation (6), the labor requirements can be estimated by utilizing labor-output coefficients $\ell_j = (L_j/x_j)$ as follows.

$$(8) \qquad \sum_{j=1}^{n} \Delta L_j = \sum_{j=1}^{n} \ell_j \, z_{j1} \, \Delta d_1 = \sum_{j=i}^{n} \ell_j \, \Delta x_j \ .$$

The stability of the labor-output coefficients (ℓ_j) as well as a_{ij} may be questioned. In the short run such coefficients can be quite stable in the absence of major changes in the product mix and technology.[4] As proved by Dorfman, Samuelson and Solow, the technical coefficients represent the optimum combinations of inputs and the optimal scales of production under existing technology and thus the minimum total cost for a given level of output.[5]

(iii) Required Intermediate Imports

The increase in the output of domestic sectors (Δx_i) needed to satisfy Δd_1 will also require additional

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4. Miernyk, op. cit., p. 109.
5. R. Dorfman, P. A. Samuelson, and R. M. Solow, Linear Programming and Economic Analysis. (New York: McGraw-Hill Co., 1958), p. 209.

amounts of intermediate imports. To estimate these, the intermediate import-output coefficients $m_j = (M_j/x_j)$ are utilized as follows.

$$(9) \qquad \sum_{j=1}^{n} M_j = \sum_{j=1}^{n} m_j z_{j1} \Delta d_1 = \sum_{j=1}^{n} m_j \Delta x_j$$

Now summing equations (7), (8), and (9) give the alternative costs of providing Δd_1 from the domestic sources other than the Aswan Dam.

(3) Estimation of Total Benefits

The demand for the electric power is expected to be mostly from manufacturing and processing sectors and thus intermediate in nature. In contrast, the demand for agricultural products is expected to be primarily for final consumption. Farm output, especially subsistence crops, will have a minimal effect on producing sectors, but an immediate and direct impact on farm income. Therefore, while the input-output model is applied in both cases, different approaches seem needed. The input-output model presented in Section 1 will be expanded to estimate the total benefits from these two products, electrical power and agricultural output.

(i) Total Benefits from Electric Power

Total (direct and indirect) benefits of the electric power of the Dam will be estimated by the net output (value added), employment and improved balance of payments position of the national economy. These benefits will be examined under two alternative sectoral development strategies. The two development strategies are balanced and unbalanced sectoral growth.[6]

a) Balanced Growth

If a balanced development strategy is followed, the additional electric power of the Dam is allocated among all the sectors of the 1971 input-output table. The share of each sector's use of electricity (directly and indirectly) will be based on its relative contribution to total final demand. If we assume that energy represents the only constraint for capacity expansion (a reasonable assumption in many developing nations), then an increase in the supply of power can support an increase in final demand of all domestic sectors. For an illustration, consider equation (3') which can be rewritten as

$$x_i = \sum_j z_{ij} d_j \, , \quad i = 1,\ldots,n$$

where 1 again is the subscript for the electrical power sector. Then supply-demand identity for the electric sector becomes

$$(10) \qquad x_1 = \sum_{j=1}^{n} z_{1j} d_j = \quad z_{11} d_1 + z_{12} d_2 + \ldots + z_{1n} d_n \, .$$

6. These terms should not be confused with the "balanced growth strategy" formulated by Rosenstein Rodan, or "unbalanced growth" of Hirschman. See Chapter 5.

If the supply of electricity increases by γ percent due to the Dam, then equation (10) becomes:

$$(11)\quad (1+\gamma)x_1 = x_1 + \gamma x_1 = \sum_{j=1}^{n} z_{1j}d_j + \gamma \sum_{j=1}^{n} z_{1j}d_{1j} .$$

Since $\quad x_1 = \sum_{j=1}^{n} z_{1j}d_j ,$

then γx_1 the additional electricity generated by the Dam could support an across-the-board increase of γ percent in the final demand of all domestic sectors as compared to their 1971 levels, i.e.,

$$(12)\qquad \gamma x_1 = \gamma \sum_{j=1}^{n} z_{1j}d_{1j} .$$

However, the increase in the final demand of the domestic sectors by (γd_j) will require the adjustment of the output levels of all sectors supplying intermediate inputs. This process will set off rounds of output changes, so that the increase in a sector's final demand will have both direct and indirect effects on each sector. The direct plus indirect responses of a sector's gross output to the increase in final demand by γ percent is then

$$(13)\qquad \Delta x_j = \Sigma\, z_{ij}\, \gamma\, d_j = \gamma x_j \quad (i,j = 1,\ldots,n)$$

i.e., gross output of all sectors also increase by γ percent. For example, the increase in sector 2's output,

$$\Delta x_2 = \sum_{j=1}^{n} z_{2j}\, \gamma\, d_j = \gamma x_2 .$$

Once the vector of the increase in the output of domestic sectors is determined, the value-added coefficients can be used to estimate the corresponding increase in total value added as follows.

$$(14) \qquad \sum_{j=1}^{n} \Delta V_j = \gamma \sum_{j=1}^{n} v_j \, x_j \; .$$

Following the same procedure, the resulting increase in total employment is

$$(15) \qquad \sum_{j=1}^{n} \Delta L_j = \sum_{j=1}^{n} \ell_j \, z_{ij} \, \gamma \, d_j = \gamma \sum_{j=1}^{n} \ell_j \, x_j \; .$$

The effect on balance of payments is also estimated by utilizing export and import output ratios as follows:

$$(16) \qquad \sum_{j=1}^{n} \text{Net Export} = \gamma \left(\sum_{j=1}^{n} e_j x_j - \sum_{j=1}^{n} m_j x_j \right) .$$

b) Unbalanced Growth

In an unbalanced growth, concentration is on expansion of few key sectors capable of triggering growth in the rest of the economy through their forward or backward linkages. The sectoral linkages can be calculated from the inverse of the input-output matrix. To accomplish this task, the two linkage indices developed by P. N. Rasmussen are used. These two indices are the power of dispersion index "U_j" and the sensitivity of dispersion index "U_i"[7] The first index determines the strength of sector j's backward linkages in terms of the direct and indirect expansion in output of all domestic sectors in order to support one unit increase in sector j's final demand. The second index (U_i) measures the extent to which the expansion in sector i's output will stimulate the production of all other sectors. The mathematical formulation of these two indices is derived from the inverse matrix.[8]

In value terms, given $z_j = \sum_{j=1}^{n} z_{ij}$ is the sum of column elements in the z matrix, and represents the direct and indirect increase in the output of all sectors needed to support an increase in final demand of sector j by one dollar. Similarly, $z_i = \sum_{j=1}^{n} z_{ij}$ is the sum of each row elements and represents the increase in sector i's output needed to support one dollar increase in each sector's final demand. Then, the set of averages

$$\frac{1}{n} z_j \quad (j = 1,\ldots,n)$$

represents an estimate of total (direct and indirect) increase in output to be supplied by a sector chosen at random if final demand for the products of sector j increases by one dollar. These averages are then

7. Rasmussen, op. cit., pp. 127-149.
8. Ibid., pp. 133-134.

normalized by relating them to the overall average defined as:

$$\frac{1}{n^2}\sum_{j=1}^{n}\sum_{i=1}^{n} z_{ij} = \frac{1}{n^2}\sum_{j=1}^{n} z_j = \frac{1}{n^2}\sum_{i=1}^{n} z_i \ .$$

The power of dispersion index U_j is:

$$(17) \qquad U_j = \frac{\frac{1}{n} z_j}{\frac{1}{n^2}\sum_{j=1}^{n} z_j}$$

while the sensitivity of dispersion index U_i is:

$$(18) \qquad U_i = \frac{\frac{1}{n} z_i}{\frac{1}{n^2}\sum_{i=1}^{n} z_i}$$

Once "key sectors" (i.e., those with the highest score of backward or forward linkages) are identified, estimation of total benefits of the additional electricity under an unbalanced growth strategy is as follows. Suppose that the government policy is to accelerate the transition of the economy from agriculture to an industry. The plan is to increase nonessential sectors' final demand by α percent less than the balanced growth, and to increase the key sectors' final demand by β percent more than the balanced growth. For this purpose, we restructure our input-output table such that the first 1 to s are the nonessential sectors and s+1 to n are the key sectors. Then the supply-demand identity for the additional electric power of the Dam becomes:

$$(19) \qquad \gamma x_1 = \sum_{j=1}^{s} (\gamma-\alpha) z_{1j} d_j + \sum_{j=s+1}^{n} (\gamma+\beta) z_{1j} d_j$$

$$= \sum_{j=1}^{n} \gamma z_{1j} d_j + \beta \sum_{j=s+1}^{n} z_{1j} d_j - \alpha \sum_{j=1}^{s} z_{1j} d_j$$

because $\sum_{j=1}^{s} \gamma z_{1j} d_j + \sum_{j=s+1}^{n} \gamma z_{1j} d_j = \sum_{j=1}^{n} \gamma z_{1j} d_j$

where $j = 1,\ldots,s$ are nonessential sectors; $j = s+1,\ldots,n$ are key sectors and 1 is the subscript of the electrical power sector.

Since the supply of the electric power made possible by the Dam is expected to be stable in the short run, and given that $\gamma x_1 = \gamma \sum_{j=1}^{n} z_{1j} d_j$, then the relationship between α and β becomes:

$$(20) \qquad \beta \sum_{j=s+1}^{n} z_{1j}\, d_j = \alpha \sum_{j=1}^{s} z_{1j}\, d_j$$

$$(21) \qquad \beta = \frac{\alpha \sum_{j=1}^{s} z_{1j}\, d_j}{\sum_{j=s+1}^{n} z_{1j}\, d_j}$$

Then, for any given value of α , we can calculate β from equation (21). Once α and β are set, full utilization of the additional electric power of the Dam would support an increase in the final demand of key sectors by $\gamma+\beta$, i.e., $(\gamma+\beta)d_j$ for $j = s+1,\ldots,n$ from their original levels as indicated in 1971 input-output table. The nonessential sectors' final demand will increase by $(\gamma-\alpha)d_j$ for $j = 1,\ldots,s$. The direct plus indirect responses to the unbalanced increase in final demand of the gross output (Δx_k) of all domestic sectors is estimated as follows:

$$\begin{bmatrix} \Delta x_1 \\ \vdots \\ \Delta x_s \\ x_{s+1} \\ \vdots \\ \Delta x_n \end{bmatrix} = \begin{bmatrix} z_{11}\cdots z_{1s}\cdots z_{1\ s+1} \\ \vdots \\ z_{s1}\cdots z_{ss} \quad z_{s\ s+1} \\ z_{s+1\ 1}\cdot\cdot z_{s+1\ s} \quad z_{s+1\ n} \\ \vdots \\ z_{n1}\cdots z_{ns}\cdots z_{nn} \end{bmatrix} \begin{bmatrix} (\gamma-\alpha)d_1 \\ \vdots \\ (\gamma-\alpha)d_s \\ (\gamma+\beta)d_{s+1} \\ \vdots \\ (\gamma+\beta)d_n \end{bmatrix}$$

or

$$\Delta x_k = \sum_{j=1}^{s} z_{kj}(\gamma-\alpha)d_j + \sum_{j=s+1}^{n} z_{kj}(\gamma+\beta)d_j$$

$$= \sum_{j=1}^{s} z_{kj}\gamma d_j - \sum_{j=1}^{s} x_{kj}\alpha d_j + \sum_{j=s+1}^{n} z_{kj}\gamma d_j$$

$$+ \sum_{j=s+1}^{n} z_{kj}\beta d_j$$

$$= \gamma \sum_{j=1}^{n} z_{kj}d_j + \sum_{j=s+1}^{n} z_{kj}\beta d_j - \sum_{j=1}^{s} z_{kj}\alpha d_j$$

$$(22') \quad \Delta x_k = \gamma x_k + \beta \sum_{j=s+1}^{n} z_{kj} d_j - \alpha \sum_{j=1}^{s} z_{kj} d_j \ , \ k = 1,\ldots,n.$$

Recalling that v_j, $j = 1,\ldots,n$ are coefficients of the value added per one dollar of gross output of sector k, then, the total (direct and indirect) increase in national income can be estimated as

$$(23) \quad \Delta v_k = \gamma v_k x_k + \beta \sum_{j=s+1}^{n} v_k z_{kj} d_j - \alpha \sum_{j=1}^{s} v_k z_{kj} d_j \ .$$

Following the same procedure, we can use the labor, import and export output ratios to estimate the increase in employment and the net effect on the balance of payments. The empirical consequences of the two alternative development strategies will provide a better basis for formulating policies regarding the use of the Dam's electric power, by permitting a comparison of the gains and losses from the different utilization patterns associated with each.

(ii) Total Benefits from Agriculture

The value of net output from the agriculture due to the Dam directly increases farm income and thus the sector's final demand (direct income effect). To estimate the corresponding total effect on national income, the sector's income multiplier is used. It is derived from equation (3) of the model.[9] Letting 2 be the subscript

9. F. T. Moore, "Regional Economic Reaction Path", American Economic Review, Vol. XLV, No. 2, 1955, pp. 133-148.

for the agricultural sector[10], the direct and indirect effects of the increase in final demand for its products (Δd_2) are given by the elements of the second column in the inverse matrix as follows:

$$(24) \quad \Sigma \, \Delta x_i = (z_{12} + z_{22} + \ldots + z_{n2}) \, \Delta d_2 \, .$$

The total corresponding increase in national income is then calculated by using value added coefficients, i.e.,

$$(25) \quad \Sigma \, \Delta v_j = \sum_{j=1}^{n} v_j \, z_{j2} \, \Delta d_2$$

The income multiplier (I_{m2}) as the ratio of total effects to direct effects alone then becomes

$$(26) \qquad I_{m2} = \frac{\sum_{j=1}^{n} v_j \, z_{j2}}{v_2}$$

Following the same procedure, employment multiplier (L_{m2}) is given by

$$(27) \qquad L_{m2} = \frac{\sum_{j=1}^{n} \ell_j \, z_{j2}}{\ell_2}$$

These multipliers, however, underestimate the complete effects of the resulting increase in final demand for farm products, because only the first income and employment rounds are included. The rise in farm income is expected to raise household consumption on goods

10. This is sector 1 in the 1971 I-O table used in this study.

and services, which then induces further increases in income, consumption and employment. Such additional rounds can only be measured if the household consumption-income relationship is incorporated in the open-static I-O model.[11] This can be done by adding a household row and column to the original inverse matrix i.e., by treating the proportion of value added that represents the payments to households as an additional production sector and treating private consumption as the input necessary for the production of these payments. Unfortunately, the 1971 I-O table used in this study does not report individual components of value added separately, and thus limits the analysis to the first round.

The model presented in this chapter is applied empirically in the following two chapters of our study.

11. See Moore, Loc. cit., p. 136. Also, Chiou-Shuang Yan, op. cit., p. 68.

CHAPTER IV

ALTERNATIVE COSTS

In this chapter, we will attempt to estimate the alternative cost of the new hydroelectric power and the net agricultural output that have resulted from the Dam. The first part of the chapter examines the energy sector in Egypt in order to quantify the net value and alternative costs of the power generated. The second part of the chapter examines the agricultural sector, in order to determine the net contribution of the Dam for agriculture and to measure the costs of alternative sources of agricultural output. Discussion on the estimation of total benefits is presented in the next chapter.

A. Energy

1. Resources

The most common sources of energy in Egypt are petroleum, natural gas and hydro-electric power. However, in the rural sector, agricultural waste (maize and cotton husk) are still widely used-- though gradually diminishing. The decline in the importance of the latter is due mainly to rural electrification scheme made possible through the electricity generated by the High Dam, as well as to the increased use of husk for manufacturing paper pulp. As for petroleum, since 1975 Egypt has become a surplus country with an export trade. This development resulted from the discoveries of oil in the Gulf of Suez and the return of the Sinai oil fields with its production of 800,000 barrels of crude oil per day.[1] Table 4-1 shows that crude oil production increased 157.0 percent during the period 1967-1976.

Table 4-1 Crude Oil Production in Egypt
(in 000 M^3)

Year	Production	Year	Production
1960/61	3,443	1974	8,533
1964/65	6,997	1975	11,734
1967/68	6,519	1976	16,756

Source: For 1960-67/68, Central Agency for Public Mobilization and Statistics (CAPMS), Statistical Handbook, 1971; for 1974, CAPMS, Statistical Yearbook, 1975; for 1975 and 1976, United Nations (U.N.), Yearbook of Industrial Statistics, New York, 1976, Vol. 2, p. 4.

Electric energy was first introduced in Egypt in 1895 with the use of diesel and oil-fired steam generators. The first hydroelectric power was produced much later, in 1961 with the establishment of a hydroelectric plant on the original Aswan Dam, which is in Aswan city. As a result, the supply of electricity increased 66.7 percent between 1960 and 1962.[2] The availability of this new

1. The Economist, Annual Supplement of 1978, p. 12.
2. Magdi El-Dammash, Economic Development and Planning in Egypt. (New York: F. Prager, 1968), p. 224.

source of energy permitted the construction of a fertilizer plant adjacent to the Dam. The plant consumes around 2 billion kw/h of electricity a year.[3]

The Aswan High Dam hydroelectric power plant began producing in 1969. Its annual generating capacity amounts to 2,100 Megawatts (MW), with a potential of 10 billion kw/h of electricity. This capacity is twice that of all thermal stations existing at the time of the Dam's completion.[4] Between 1974-1977, the High Dam's hydroelectric plant operated at slightly more than half its annual installed capacity. According to Mr. William Shenouda, the Undersecretary of State in charge of the High Dam, "only five or six of the Dam's twelve turbines were being used, producing between five billion and six billion kilowatts of power a year."[5]

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3. UNIDO, UNIDO/TSKB Joint Seminar on Project Promotion in Backward Regions, (Istanbul, 1977), pp. 359-365.
4. Robert Mabro, The Egyptian Economy, 1952-1972. (Oxford: Clarendon Press, 1974), p. 103.
5. The New York Times, "Debate Flares in Egypt over Effects of Aswan Dam", Sunday edition, May 4, 1975. See also Christian Science Monitor, "Aswan Dam Had Failed to Meet Egypt's Great Expectations", January 26, 1975. The Monitor article reports: "Electric power officials now acknowledge that its hydroelectric output falls far short of its goal, and that even when all 12 turbines are in use, the Dam will never produce the 10 billion kilowatt hours of power a year Egypt has long said it would."

2. Price Structure of Electricity

Production and pricing of electricity in Egypt is monopolized by the government. Prices are set at different rates for different users. The industrial sector as a bulk user paying the lowest rates increased its use of electricity from 43 percent of total production in 1965 to 55 percent in 1970.[6] The household sector, with a relatively inelastic demand, pays the highest rates. Until 1974/75, while industrial bulk users, such as the fertilizer plant in Aswan, were paying an average of 4 milliemes per kw/h, the household sector was paying 21 milliemes per kw/h.[7] This pricing, evidently favors natural monopolies, while it discriminates against the household sector.

3. Alternative Costs

The value of the hydroelectric power generated by the High Dam is used to estimate the alternative cost. In deriving this value, the following assumptions are made. First, only the Dam's actual generating capacity as of 1974/75 (5 billion kw/h annually) is used in our analysis. The reason that we are limiting ourselves to the actual instead of the maximum potential power is the lack of information about when and how this potential will be achieved. Underutilization of the Dam's power capacity

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6. CAPMS, Statistical Indicators, 1952-1972. Cairo, July 1973, p. 215.
7. National Bank of Egypt, "The Benefit-Cost Analysis of the High Dam", Economic Bulletin, Vol. 18, 1965, p. 274. One Egyptian pound (LE) - 1,000 milliemes.

is not simply a technical problem nor a consequence of insufficient demand. It also is due to differences in the timing of the use of water for irrigation as against power generation.[8] The data presented in Table 4-2 shows that in the six months of April to October, climatic conditions are favorable for agriculture. It is then that there is a natural complementarity in the demand for water to satisfy both agricultural and hydropower needs. The water turning the turbines is also used for irrigation. In contrast, during the other six months of October to April, if water is released to satisfy the relatively small agricultural needs only, the water flow will be insufficient to generate enough electricity. The demand for water for hydroelectric power is relatively steady during the year, unlike that for irrigation. A steady high flow of water throughout the year will be required to generate the maximum output of power possible. In this case, a large percentage of the water will be lost to the Mediterranean Sea and be unavailable later for farming. There also the possibility of flood damage recurring from the heavy water flow.

The second assumption is that the 1971 price of 21 milliemes per kw/h for residential use is paid by all

8. Harold A. Thomas, Jr. and Roger Revelle, "On the Efficient Use of High Aswan Dam for Hydropower and Irrigation", Management Science, Vol. 12, No. 8, April 1966, pp. B-296 - B-360.

Table 4-2 Seasonal Distribution of Water Inflow to Lake Nasser and Water Demand for Agriculture and Power Generation, Aswan Dam

(Figures represent percentages of annual supply and demand)

Season	Inflow to Lake Nasser	Hydropower Demand	Irrigation Requirement
Jan.-March	9	28	15
April-June	3	25	34
July-Sep.	53	22	35
Oct.-Dec.	35	25	16
	100	100	100

Source: Harold A. Thomas Jr. and Roger Revelle, "On the Efficient Use of High Dam for Hydropower and Irrigation," Management Science, Loc. cit., p. B-298.

buyers. This assumption eliminates government subsidies to bulk and industrial users. The third assumption is that the marginal cost of supplying one kw/h of electricity at the plant site is an estimated 0.5 millieme[9], as compared to 2.5 milliemes for supplying it to northern regions. Hydroelectric power transmitted to northern regions is supposed to account for 60.0 percent of the plant's output. The other 40 percent is supposed to be used in Aswan and adjacent regions.[10] The final assumption is that even without the Dam the exogenous increase in demand for electricity will be equal to 5 billion kw/h a year, which is the amount we have assumed the Dam will actually furnish. This assumption is justifiable in Egypt, as in most developing countries, because of the shortage of energy for industrialization.

From the first two assumptions, the value of electricity generated annually by the Dam is calculated at LE 105 million (5 billion x .0221). From the third assumption, the total cost of generating the Dam's 5 billion kw/h of electricity amounts to LE 8.5 million (0.6 x 5 billion x .0025 + 0.4 x 5 billion x .0005). Thus, the net value of the additional electricity is

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9. National Bank of Egypt, *loc. cit.*, p. 274. See also Robert Mabro, who writes that "based on the very low cost of operating the Dam's hydroelectric stations the marginal cost of electricity at source is virtually zero," *op. cit.*, p. 104.

10. National Bank of Egypt, *loc. cit.*, p. 247.

calculated at LE 96.5 million a year. Next we compute the cost of alternative sources of supply. There are three components of alternative cost, resource inputs, labor requirements and intermediate imports.

(i) Resource Inputs

If, as we have assumed, there exists an exogenous demand for electricity equal to the value of the electricity generated by the Dam, final demand for electricity will have increased by LE 96.5 million a year. If traditional sources such as thermal or steam plants are used to satisfy this increase in demand, the alternative cost is measured by the required increase in, or reallocation of, the output of those domestic sectors that furnish inputs to the electric power sector. This cost can be calculated by using equation (6') of the model presented in Chapter 3,

$$\sum_{i=1}^{n} x_i = \sum_{i=1}^{n} z_{i1} \; \Delta d_1 \quad ,$$

where z_{i1} is the electric sector column of the inverse of the technical coefficients matrix of the 1971 Egyptian I-O table (presented in Appendix A-2), and Δd_1 is the exogenous increase in the demand for electricity. For ease of presentation the calculations have been aggregated in nine sectoral groups in Table 4-3. The table shows that the alternative cost of traditional sources as measured by gross output of domestic sectors totals LE 112.5 million.

If we consider the gross value of electricity used

Table 4-3 Total (Direct and Indirect) Required Output to Meet the Increase in Demand for Electricity Using Traditional Power Sources (000 LE)

Sectoral Groups	Δx_j Total (Direct and Indirect) Required Output	Δv_j Value Added
Agriculture and Agro-based Industries[a]	LE 160	72
Mining, Oil, Coal and Oil Products	5,480	3,612
Transportation and Storage	5,270	3,371
Services	2,900	2,504
Basic Metal and Metallic Industries	480	190
Electricity (96,500[b] 200[c])	96,700	76,360
Construction	450	212
Electricity and Nonelectrical Machinery	660	302
All Other Domestic Sectors[d]	440	213
	112,540	86,826

a) The group includes: Agriculture; Pressing and Ginning; Food Processing; Beverages and Spinning and Weaving sectors.
b) Required electricity needed to satisfy the increase in final demand.
c) Required electricity needed (directly and indirectly) to support the increase in the production of all sectors (intra-industry transactions).
d) All other sectors include: Tobacco; Ready-Made Cloth; Wood and Wood Products; Paper; Publishing and Printing; Leather; Rubber; Chemicals and Nonmetallic Industries.

directly and indirectly within the processing sectors alone, which amounts to LE 200 thousands, then the gross value of indirect required output from all sectors, including the electrical, amounts to LE 16.04 million. The burden falls unevenly among productive sectors. Those with strong forward linkages with electric power carry the major burden in terms of expanding their output or diverting it from other uses. In Egypt these sectors are mining, coal and oil products, transportation, and services. These four sectors account for 85 percent of the total resources needed to produce the LE 96.7 million of additional electricity by traditional methods. (See Table 4-3).

The alternative cost in terms of the value of the net output (direct and indirect) required by domestic sectors to produce this extra power amounts to LE 86.8 million, as presented in Table 4-3. We arrived at this figure by applying value added coefficients to the new vector of sector's output,

$$\sum_{j=1}^{n} V_j = \sum_{j=1}^{n} v_j \, \Delta x_j ,$$

which is equation (7') of the model.

(ii) Labor Inputs

This section presents the implications for industrial employment (in man-years) of using the traditional sources of electric power. To derive these man-year figures, it is necessary first to convert the industrial distribution of employment in 1971 into the sectoral classifications used by the 1971 Input-Output table[11], and then use the labor-output coefficients into equation (8) of the model,

$$\Delta L = \sum_{j=1}^{n} \ell_j \, \Delta x_j ,$$

where $\ell_j = (L_j/x_j)$. Total direct and indirect employment amounts to 52,866 man-years. They are needed to provide the output of LE 112,540,000 to meet the final demand for electricity. (See Table 4-4.)

The LE 200,000 of electricity needed by all production sectors (intra-industry transactions) requires only 61 man-years of employment. Transportation and services account for most of the indirect employment (84.9 percent) absorbed by all the production sectors. This share of employment far exceeds the combined share (50.9 percent) of output required by these two sectors. (See Tables 4-3 and 4-4.) In contrast, the employment share of mining and coal and oil products is far less than their corresponding combined share of output. This finding indicates the relative intensity of labor input and corresponding differences in productivity. If we assume that labor productivity in

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11. Two statistical sources were needed, one for manufacturing and the other for all nonmanufacturing. The UN, Yearbook of Industrial Statistics, Vol. 1, 1974, supplied the first; CAPMS, Statistical Yearbook, op. cit., 1975, supplied the second.

Table 4-4 Total (Direct and Indirect) Employment Required to Meet the Increase in Demand for Electricity Using Traditional Power Sources (in man-years)

Sectoral Group	Man-Year	%[c]
Agriculture and Agro-Based Industries	304	2.0
Mining, Oil, Coal and Oil Products	634	4.2
Transportation and Storage	8,000	52.5
Services	4,930	32.4
Basic Metal and Metallic Industries	160	1.0
Electricity (37,635[a] 61[b])	37,696	0.4
Construction	671	4.4
Electricity and Nonelectrical Machinery	332	2.2
All Other Domestic Sectors	139	1.0
	52,866	100.0

a) Needed to produce the output to satisfy the final demand for electricity.
b) Needed to produce the amount of electricity supplied to other processing sectors, i.e., direct and indirect intra-industry transaction.
c) Percentage distribution of employment requirements (15,053 man-years) among industries in processing sectors. It excludes the 37,635 man-years needed in the electrical sector to produce the amount of electricity needed to satisfy the final demand.

Egypt increases as the capital-labor ratio increases, mining, and coal and oil products evidently are capital intensive, while transportation and services are labor intensive.

(iii) Intermediate Imports

The increase in the output of the domestic sectors will place a burden on the balance of payments. The magnitude of this burden is given by the value of the intermediate imports required by these sectors. To calculate this figure, we first derive the import-output coefficient ratios from the 1971 I-O table and then, apply these coefficients to the gross changes in sector's output (Δx_i), as indicated by equation (9) of the model. The results of our calculations are aggregated by the same nine sectoral groups used before and are provided in Table 4-5. The latter shows that the increase in intermediate imports totals LE 9.397 million which, all things equal, adds a corresponding amount to the balance of payments deficit.

(iv) Summing up

Our empirical findings show that the increase in the demand for electricity in Egypt is achieved in the most efficient i.e., least expensive way by using the hydroelectric stations of the High Dam. We find the annual cost of generating 5 billion kw/h of electricity from the Dam amounts to only LE 8.5 million as compared

Table 4-5 Value of Intermediate Imports Required by Processing Sectors to Meet the Increase in Demand for Electricity, Using Traditional Power Sources

Sectoral Group	Value of Imports (in 000 LE)	Percentage Distribution by Sectoral Group
Agriculture and Agro-based Industries	LE 8	.08
Mining, Oil and Coal and Oil Products	970	10.32
Transportation and Storage	581	6.18
Services	0	0.0
Basic Metal and Metallic Industries	76	0.80
Electricity	7,540	80.23
Construction	28	0.29
Electrical and Nonelectrical Machinery	110	1.17
All Other Domestic Sectors	84	0.89
Total	9,379	100.00

to LE 86.8 million using traditional methods. The savings to the national economy then amounts to LE 78.3 million annually. Moreover, power from the Dam saves LE 9.397 million in potential imports.

We also find that with the traditional methods, the burden in terms of the indirectly required resources and employment is unevenly distributed; it is borne by a few domestic sectors, namely mining, oil and coal products, transportation and services. There is a gain in employment of 52,866 man-years. However, except in the service sector, these represent primarily semi-skilled and skilled jobs, the labor for which is in relatively short supply, and probably will have to be diverted from other sectors in the economy.

B. Agricultural Products

1. Structure and Development of the Agricultural Sector.

Prior to construction of the Aswan High Dam, the agricultural sector faced severe constraints. The limited and irregular supply of water, derived mainly from the Nile River, had restricted expansion of both habitable and cultivable land areas. Between 1907-1960, the inhabitated area increased by only 2.5 percent, while population more than doubled. As a result, population density rose by 125.4 percent[12]. During the same period, the

12. Computed from Table 3-13, CAPMS, Population and Development, op. cit., p. 171.

rural population increased 78 percent while cultivable land increased only 9.3 percent. The pressure of the rural population on the relatively inelastic supply of cultivable land resulted in an even more unfavorable land-labor ratio. See Table 4-6. The decline in this ratio was reflected in low and declining farm labor productivity and earnings. The daily wage rates of farm laborers not only continued to lag behind the national average, but this gap widened between 1950 and 1960.[13]

Relatively low and falling farm wages and productivity, encouraged people to migrate, and worsened the already high population density in urban areas, chiefly Cairo and Alexandria. By 1969, the percentage of those born elsewhere in the labor forces of these two cities was 50.7 percent and 36.8 percent respectively.[14] While this rural to urban migration may enhance urban capital formation at the onset of economic development, it puts an extra burden on existing social overhead in urban centers whose size has already surpassed an optimal level. Moreover, farm migrants whose skills usually do not match those needed in these urban centers are forced

13. Between 1950 and 1960, agricultural wages as a percentage of the average industrial wage rate declined from 34.4 percent to 31.8 percent. See Institute of National Planning, "Allocation of Resources with Unlimited Supplies of Labor, An Application in the case of Egypt", Memorandum 905, Cairo, 1969, pp. 7-9.
14. Calculated from, CAPMS, Employment Sample Survey of 1969, Cairo, 1972.

Table 4-6 Rural Population, Cultivated Area, and Feddans Per Person in Rural Population, Egypt, Selected Years, 1907-1960

Year	Rural Population (million)	Cultivated Area (millions feddans)[a]	Feddans Per Rural Person
1907	9,508	5.4	.60
1927	10,367	5.5	.53
1947	12,603	5.8	.46
1960	16,120	5.9	.37

Source: Computed from Tables 2-5-1 and 3-1-4, CAPMS, Population and Development, op. cit., p. 139 and 172.
a) One feddan = 1.038 Acres.

to accept jobs or create work for themselves in an evergrowing marginal service sector, offering no possibility for economic improvement. Further, fragmentation of land holdings and the absence of nonfarm job opportunities in both rural and urban areas has resulted in relatively high rates of hidden unemployment.[15]

2. The Aswan Dam and the Agricultural Sector

It was only during the 1960's that this sector experienced major developments. Among these were the construction of the Aswan High Dam and the simultaneous reclamation of new land and improvement of irrigation and drainage facilities. The sector's share of total gross investment in the First Five Year Plan (1960/61-1964/65) amounted to 23.4 percent. Most of this investment was allocated for land reclamation and improvement of irrigation facilities. These activities represented 45.2 percent and 29.1 percent respectively of total investment in the sector.[16] However, in the Second Five Year Plan (1965-1970), the agricultural sector's share in total investment declined to 20.8 percent.[17]

The construction of the Aswan High Dam (begun in January 1960 and completed in 1970) represented the final

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15. International Labor Organization(ILO), Rural Employment in the United Arab Republic. (Geneva, 1969), p. 128.
16. Robert Mabro, The Egyptian Economy 1952-1972, op. cit., p. 117.
17. CAPMS, Population and Development, op. cit., p. 266.

stage in the improvement of the Egypt's irrigation system. The Dam's main function is the so-called "century storage"[18] of the water of the Nile protecting the country against both seasonal and annual fluctuations in the supply of water. The Dam also permits expansion of cultivable acreage. The "century storage" is achieved by the Dam's reservoir (Lake Nasser) with its storage capacity of 157,000 million cubic meters. The most reliable cost estimate of the Dam itself is LE 320 million, and of expenditures on related projects, LE 240 million, with land reclamation receiving the largest share (62.5 percent)[19].

The government list of expected contributions to agriculture from the Dam includes: an expansion of the amount of cultivable land by 1.2 million feddans; increase of cropped area by 850,000 feddans from conversion of cultivable land in Upper Egypt from basin to perennial irrigation and rise of net agricultural output from changes in crop patterns.[20] These objectives are still far from being achieved. The Arab-Israeli Wars of 1967 and 1973

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18. Mabro, op. cit., pp. 82-116.
19. Ibid., p. 93. The available evidence on the cost of the Aswan High Dam and related projects is controversial. While a National Bank of Egypt study in 1965 states that the cost of the Dam itself was LE 415 million, CAPMS, lists it at LE 500 million. Moreover, a New York Times interview with government officials (May 4, 1975) states that their estimate of the cost of the Dam and related projects amounts to 1 to 1.5 billion dollars. This would equal LE 586 million (if the official exchange rate at the time of 1 U.S. dollar = .391 LE is applied).
20. Ibid., p. 38.

and the shortage of foreign funds have considerably delayed implementation of complementary projects such as land reclamation and construction of other infra-structure. Our knowledge of the date and nature of the required investments is limited. Therefore, we avoid unsupported guessing by confining the analysis to the following actual, quantifiable contributions of the Dam to the agricultural sector, using the most recent available data.

(i) Shift from Lower Yield Nili Maize to Higher Yield Summer Maize.

The shortage of water during the summer represented the main constraint to cultivation of the high yield summer maize. Farmers had adapted to this situation by growing a lower yield maize during the flood (Nili) season. However, since 1964, when water from the Aswan Dam first became available during the summer, farmers responded swiftly and shifted to summer maize. Table 4-7 shows that the proportion of feddans planted in high yield summer maize increased from 3 percent in 1960 to 79 percent in 1974. In addition, the acreage yield increased 59.6 percent (1.50 tons/feddan in 1974 compared to 0.94 ton/feddan in 1960).

Using the government price of LE 42.08 per ton of maize in 1974 and the data in Table 4-7, the net increase in farm income resulting from the switch to summer maize amounted to LE 41.35 million (0.56 ton increase in average yield per feddan times LE 42.08 price per ton times 1,755 thousand feddans of maize in 1974).

Table 4-7 Acreage and Yield of Maize, Egypt, 1960 and 1974

	1960	1974
High yield (summer) maize (000) feddans	56	1,387
Low yield (Nili) maize	1,794	368
Total acreage	1,850	1,755
Total yeild (000) tons	1,691	2,640
Average yield (ton/feddan)	.94	1.50

Sources: 1974 figures computed from CAPMS, Statistical Yearbook, 1975; 1960, from CAPMS, Statistical Abstract, 1971.

(ii) Expansion in Rice Acreage

Rice is considered to be one of the most profitable crops in Egypt. It also is one of the main exports. However, its cultivation requires the most water of all crops. The government planned the transfer of an additional one million feddans of cultivable land to rice, thus achieving a higher degree of efficiency in the allocation of the additional water among high value crops. Nevertheless, Table 4-8 shows that only one third of this target (345 thousand feddans) has been achieved by 1974. Utilizing the data in Table 4-8, value of net yield attributable to the additional water used amounts to LE 13.1 millions at

1974 prices.[21]

Table 4-8 Acreage and Yield of Rice, Egypt, 1960 and 1974

	1960	1974
Acreage (000 feddans)	706	1,051
Total yield (000 tons)	1,486	2,242
Average yield (ton/feddan)	2.10	2.13
Value of yield/feddan (in LE)[a]	LE 75.6	LE 76.68
Cost of cultivation/feddan (in LE)[a]	LE 38.87	LE 38.78
Net yield/feddan (in LE)[b]	LE 36.73	LE 37.90

Note: a) Yield and cost are valued at constant 1974 prices.
b) The difference between the average yield and average cost per feddan.

Sources: Rice acreage and yield, CAPMS, Statistical Indicators 1971 and Statistical Yearbook, 1975; cost, Ministry of Agriculture, Agricultural Research Institute.

(iii) Expansion in Sugar Cane Acreage

Climate and proximity to sugar refineries has limited the expansion of sugar cane acreage to southern Egypt. Table 4-9 reveals that although sugar cane acreage increased by 62 percent between 1965 and 1974, its average yield declined by 8.4 percent. The decline in productivity is due to the expansion on newly reclaimed land of lower fertility. Given the data of Table 4-9 and following the

21. Net yield value from additional water used = net yield value per feddan of price in 1974 x change in rice acreage.

same procedure as in the case of rice, the net contribution of the Dam's water for the irrigation of additional sugar cane acreage amounts to an annual LE 10.9 million at 1974 prices.

Table 4-9 Acreage and Yield of Sugar Cane, Egypt, 1965 and 1974

	1965	1974
Acreage (000 feddans)	129	209
Total yield (000 tons)	4,739	7,018
Average yield (tons/feddan)	36.7	33.6
Value of yield/feddan (in LE)	256.9	235.2
Cost of cultivation/feddan (in LE)	99.10	99.10
Net yield/feddan (in LE)	157.8	136.1

Source: Same as Table 4-8.

(iv) Change from Basin to Perennial Irrigation

Controlling the river's water during its flood season has resulted in the conversion of 850 thousand feddans of farm land in southern Egypt from basin to perennial irrigation. This change, completed by 1972[22], permitted cultivation of more than one crop a year on the same site. In addition, flexiblity in the timing of irrigation and in the supply of water resulted in

22. Mabro, op. cit., p. 98.

an increase in the productivity of land. In view of the ratio of 5:3 between cultivable and cropped land, with multi-cropping[23], the net addition of cropped area amounts to approximately 510,000 feddans (850,000 x $\frac{3}{5}$). From the data presented in Table 4-10, the net yield value of one feddan of cropped area in 1974 is calculated at LE 79.97. Based on this figure, the net contribution to farm income of converted land is LE 45.3 million at 1974 prices.

(v) New Reclaimed Land

Although the ambitious government program to fully utilize the Dam's water aimed at the reclamation of 1.2 million feddans, the latest statistics reveal that by 1971 only 829,703 feddans had been reclaimed. However, according to Mabro, the Dam's water benefited only 650,000 feddans of this land.[24] The irrigation of the remainder (179,703 feddans) depends mainly on other sources of water or on small Nile surpluses available before the Dam. The existence of another 550,000 feddans of good land suitable for cultivation is questionable.[25]

In estimating the net yield value of the newly reclaimed land, three assumptions are made. First, the cost of cultivating the reclaimed land is similar to that

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23. For example, the multicropping of 6 feddans of farm land means a total cropped area (in a year) of 10 feddans, CAPMS, Population and Development, op. cit., p. 157.
24. Mabro, op. cit., p. 100.
25. Ibid., p. 101.

Table 4-10 Determination of Net Yield Value Per Feddan of Cropped Land, Egypt, 1974

Gross Value of Agricultural Output (million LE)		LE 1,769.2
Total Cost of Production:		
a) Intermediate Inputs and Capital Depreciation (in million LE)	452.0	
b) Wages (in million LE)	298.1	
c) Rent (in million LE)	137.7	887.8
Total Net Yield Value (in million)		881.4
Total Cropped Area (in million feddan)		11.021
Net Yield Value Per Feddan of Cropped Area (in LE)		79.97

Sources:
1) Gross value of agricultural output, total cropped area and wages; CAPMS, Statistical Yearbook, 1975.
2) Intermediate inputs; Ministry of Agriculture, Agricultural Research Institute.
3) Rents: estimates based on an average of LE 21 per feddan. About agricultural land rent in Egypt, see Mahmound Abdel-Fadil, Development, Income Distribution and Social Changes in Rural Egypt (1952-1970). (Cambridge: Cambridge University Press, 1975), pp. 51-76.

of existing cultivated land. Second, annual allocation of the reclamation cost is equal to the average rent paid on cultivated land. Third, the reclaimed land is multicropped in the absence of evidence of contrary utilization patterns. However, productivity of a feddan of reclaimed land is only 62 percent of that of already cultivated land.[26] Based on these assumptions and data in Table 4-10, the net annual increase in farm income from reclaimed land amounts to LE 51.6 million at 1974 prices.[27]

(vi) The Economic Cost of Lost Silt

The completed Dam acts as a silt trap, depriving agricultural land from the silt that the river once deposited during the flood season. These deposits improved the physical conditions of exhausted soil at zero cost. Our own estimate sets the nutrition value of lost silt at LE 9.38 million annually. We arrive at this figure by multiplying the percentage increase (17.7 percent) in use per feddan of nonorganic fertilizers between 1970 and 1974 (see Table 4-11), by the total value of fertilizers used in 1974 (LE 53 million).

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26. Institute of National Planning, "Models Used in Drafting the 20-Year Plan (1959-78)", Memorandum 225, Cairo, 1962.
27. We arrived at this figure as follows. Acreage of reclaimed land in terms of cropped area = 650,000 x 1.6 = 1.04 million feddans. Net yield value per cropped feddan = LE 79.97 x .62 = LE 49.58. Total net yield value = LE 49.58 x 1.04 million feddans = LE 51.6 million.

Table 4-11 Use of Nonorganic Fertilizers, Egypt, 1970 and 1974

Year	Cropped Area (000 feddans)	Nonorganic Fertilizers (000 tons)	Per Feddan Use (ton/feddan)
1970	10,750	1,173	.11
1974	11,021	1,415	.13

Source: CAMPS, Statistical Handbook, 1975.

To summarize, net agricultural contributions of the Dam amount to LE 152.8 million annually at 1974 prices.

3. Alternative Cost

Measuring the alternative cost of the net agricultural contributions would require an estimate of the cost of a feasible alternative source that would provide the same amount of irrigationed water. Such an alternative does not exist in Egypt, which is completely dependent for water on the Nile river. Therefore, the model developed in Chapter 3 cannot be applied.

Another measure of the alternative cost of the Dam's water is the amount of foreign exchange needed to import grain and other agricultural products equal in quantity to those due to the Dam. However, two problems arise. First, although it is possible to quantify the annual net increase in maize, rice and sugar cane[28], the highly aggregated

28. See Tables of 4-7, 4-8 and 4-9.

agricultural statistics available preclude us from determining the physical volume of crops resulting from perennial instead of basin irrigation, and from the newly reclaimed land. Second, use of foreign exchange as a measure of the alternative cost for maize and rice, probably will overstate the Dam's net contribution because of the sharp rise in international grain prices over this period. Between 1972 and 1974, the period under investigation, the price of Egypt's imports of maize and wheat increased 180.7 and 281.2 percent respectively, while the price of Egypt's exported rice rose 568.8 percent.[29] In actuality, any government effort to release enough resources to obtain grain from alternative sources would be impossible.[30]

Due to these limitations, the problem will be approached by asking: In the absence of the Dam, how much would it have cost the government to maintain the prices

29. Percentages calculated from, UN, Yearbook of International Trade Statistics, New York, Vol. 1, 1974.

30. The government's ability to reduce aggregate demand by LE 152.8 million is very limited, because of the political repercussions. In Egypt, in 1973 and 1974, household consumption constituted 64.4 and 65.6 percent of aggregate demand for these two years respectively. Total expenditures on food alone as a proportion of total household spending increased from 59.5 to 62.5 percent between the two years. This increase was due mainly to an increase in population rather than an increase in per capita consumption. For more analysis of the impact on the Egyptian economy of removing food subsidies, see, Lance Taylor, "Food Subsidies, Macro and Micro Issues", Draft Report, M.I.T., 1976.

at their pre 1972 levels of a volume of farm products equal to the net agricultural output attributable to the Dam, i.e., the amount of subsidy needed to close the gap between the international and domestic prices of grains? Without the Dam, the net output of the agricultural sector as well as national product would have been reduced by the same amount as the Dam's contribution of LE 152.8 million.

In 1974 "the resource gap", that is, the net export deficit as a percentage of domestic GNP amounted to 11.8 percent. In the absence of the Dam, this gap would have become 16.3 percent. (See Table 4-12). If we assume that 1974 ratio of food subsidies to net export deficit does not change, government outlays on food subsidies would have increased by LE 160.9 million. This increase is almost 50 percent of the construction cost of the Dam itself. In the long run, the situation is even worse, if Egypt would have to purchase an equal amount of grains at rapidly rising international prices, so that the terms of trade would become increasingly adverse.

Table 4-12 Gross National Product and Total Spending, at Current Prices, Egypt, 1974 (Million LE)

		Actual	Without the Dam
GNP		3,949	3,796
Private Consumption		2,589	2,589
Food	1,681.1		
All other	970.9		
Government Consumption		1,097	1,097
Investment		730	730
Net Exports		-467	-620
Net Exports as a Percentage of GNP		11.8	16.3
Food Subsidies (1974/75)		491	652

Sources: GNP and total spending in 1974: National Bank of Egypt, Economic Bulletin, "Special Studies 1976 plan", Vol. 29, No. 4. Food subsidies in 1974/75: Lance Taylor, "Food Subsidies and Income Distribution in Egypt", op. cit.

CHAPTER V

TOTAL BENEFITS

In the preceding chapter, we estimated the initial economic changes and associated alternative costs due to the Dam. These initial changes, especially the additional electric power, are expected to induce further changes and alter the production possibilities of all other sectors, thus creating rounds of further adjustments. The latter can be translated into increases in the gross output of domestic sectors, employment and national income and into savings in foreign exchange, all of which then can be used to approximate the total benefits of the Dam to the national economy. This chapter is devoted to measuring these total benefits; we first examine the importance of energy to economic development and industrialization in Egypt. We then identify two groups of key sectors. Each group consists of six sectors with the strongest forward and backward linkages. Third, using the I-O model described in Chapter 3, total benefits of the Dam's electric power are estimated under two alternative development strategies, namely, balanced and unbalanced. The unbalanced growth strategy is considered because of the lack of an explicit government plan for using the additional electric power.

Under the balanced growth strategy, the additional electric power of the Dam is allocated among all sectors of the economy. The share of each sector is based on its proportionate contribution to total final demand in the 1971 input-output table. Under the unbalanced growth strategy, it is assumed that government policy is to expand the key sectors by increasing their share of the extra supply of electric power. Here our hypothesis is that by concentrating on the key sectors, mainly those with the highest forward linkages, gains to the national economy may be maximized. Finally, the benefits of the net agricultural output attributed to the Dam are measured by their direct and indirect effects on farm income and employment.

(1) Energy and Economic Development

In theory, there seems to be no question that a scarcity of energy retards economic growth just as abundant supplies of energy favor it. However, a priori evidence does not confirm this relationship. For example, the U.S.A. was favored by large supplies of inexpensive energy resources and experienced high rates of energy consumption during the period 1850-1910, when the country was in the process of building its industrial base. In contrast, mere availability of cheap hydroelectric power in many African countries has not in itself assured high rates of economic growth.[1]

1. Moore, ed., op. cit., p. 3.

the slow growth of GNP but rapid expansion of urban population.

As for the relationship between electric power and industrialization, our hypothesis is that the availability of electric power and the growth of industrial output are closely connected. This relationship is tested by estimating an aggregate production function for 57 manufacturing industries using the 1967 industrial survey, the latest available. The production function is given by the following equation:

$$Q = c K^{\alpha} L^{\beta} E^{\gamma}$$

where Q is the output of each of the 57 industries.

K is their capital stock.

L is the number of workers.

E is electric power used, measured at 1967 prices.

The estimated equation is:

$$\text{Log } Q = \underset{(2.039)}{1.0207} + \underset{(3.359)}{0.2419} \log K + \underset{(7.713)}{0.7603} \log L + \underset{(1.899)}{0.1277} \log E.$$

$$R^2 = 0.905 , \qquad F = 167.44 .$$

(Again, the figures in parentheses are t-values).

In addition to the two customary factor inputs, capital and labor, electric power proves to be significant (at 0.05 confidence level) in explaining the variation in output among manufacturing industries.

The importance of electricity for industrialization is also indicated by the spatial distribution of its use. Table 5-1 shows that electric power use follows the geographic location of industry. The combined share of Cairo, Alexandria and Aswan, the three main industrial centers, accounts for 85.3 percent of the total use of electric power for industrial purposes.

Table 5-1 Geographic Distribution of Industrial Use of Electric Power, Egypt, 1966-67

Region	Absolute (000 LE)	Percent
Greater Cairo[a]	5,350	48.9
Alexandria	2,249	20.5
Aswan	1,870	17.1
Suez Canal Zone	302	2.8
Northern Governorates[b]	1,040	9.5
Southern Governorates[c]	134	1.2
Total	10,945	100.0

Source: CAPMS, Census of Industiral Production 1966/67. Cairo, 1971.
a) Greater Cairo includes adjacent Giza and Kaluobia governorates.
b) Northern Governorates, excludes Kaluobia.
c) Southern Governorates excludes Giza and Aswan.

The concentration of industry in Greater Cairo and Alexandria can be attributed to the size of their urban markets, proximity to other firms, availability of supporting services, and infra-structure.[2] The industrial concentration in Aswan is explained by the economic advantages of cheap hydroelectric power provided by the original Dam. The latter attracted the location of raw-material oriented industries such as fertilizers, sugar cane and iron ore processing.

(2) Identification of Key Sectors

In estimating the benefits of the Dam's electric power according to two alternative growth strategies, we need to identify key sectors. To do this, the two linkage indices of Rasmussen presented in Chapter 3 (equations 17 and 18) are calculated for each sector from the inverse of the technical coefficients matrix of the 1971 I-O table. To repeat, the two indices are: (i) the power of dispersion index U_j which measures the strength of backward linkages of sector j, and (ii) the sensitivity of dispersion index U_i, which determines the extent to which the increase in the output of sector i will stimulate the production of all other sectors.[3] All the calculated

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2. For a detailed analysis of the spatial location of industries in Egypt, see for example, Kenneth M. Barbour, The Growth, Location and Structure of Industry in Egypt. (New York: Praeger Publishers, 1972), especially Ch. 5.
3. The interflow matrix of the I-O table can also be used to measure backward and forward linkages, where

$$U_j = \sum_{i=1}^{n} (X_{ij}/x_j) \quad \text{and} \quad U_i = \sum_{i=1}^{n} (X_{ij}/x_i)$$

However, these give only direct linkages. See Albert O. Hirschman, The Strategy of Economic Development. (New Haven: Yale University Press, 1958), pp. 98-104. Also see Chenery and Clark, op. cit., pp. 201-247.

indices are presented in Appendix A-3. The six sectors with the highest forward and backward linkages are shown in Table 5-2.

Spinning and weaving appears to be the sector with the highest backward linkages. Agriculture is the most important intermediate primary sector as indicated by its relatively strong forward linkages or output multiplier. The petroleum products sector unexpectedly is not in group 2. Its relatively weak forward linkages (see Appendix A-3) can be attributed to the loss of the Sinai oil fields during 1967 War and the destruction of the Suez oil refineries during the War of Attrition in 1969. However, this sector is among those with the highest forward linkages if the 1966 I-O table is used.[4]

Spinning and weaving, food processing and chemicals are found in both groups of key sectors. The importance of these three industries is longstanding. Their indices derived from the 1966 I-O table also are high.[5] In

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4. From the inverse of the technical coefficients matrix of the 1966 I-O table, the power dispersion index of the oil and coal mining sector is 0.94, while the sensitivity of dispersion index is 1.94, second to agriculture, with a sensitivity of dispersion of 3.22.
5. These findings should be interpreted with caution. The magnitude of the linkage indices is influenced not only by the network of sectoral technical relationship, but also by a sector's definition, classification, and degree of aggregation. (See Rasmussen, op. cit., p. 143.) In this respect, the 1966 and 1971 I-O tables are not comparable. The 1966 I-O table published by CAPMS includes 34 sectors. The 1971 I-O model constructed by the Ministry of Planning is more aggregated. It consists of only 27 sectors. The 1966 interflow matrix could not be

Table 5-2 Key Sectors of the Egyptian Economy, According to Backward and Forward Linkages, Listed from Highest to Lowest, 1971

Group (1)

Sectors with the Highest Backward Linkages (U_j)	
Spinning and Weaving	1.48
Pressing and Ginning	1.43
Food Processing	1.34
Chemicals	1.32
Metallic Industries	1.31
Construction	1.29

Group (2)

Sectors with the Highest Forward Linkages (U_i)	
Agriculture	2.67
Iron and Steel	1.87
Spinning and Weaving	1.56
Food Processing	1.31
Transportation	1.29
Chemicals	1.25

addition to the strong linkages of the three, their strategic role also derives from their remarkable contributions to foreign earnings and to upgrading the skill composition of the labor force. In 1970, the three accounted for 72.3 percent of manufacturing exports.[6] Exports of textiles and related products dominated, responsible for 57.5 percent of industrial exports. The dominance of textiles is due to the comparative advantage of the Egyptian economy in producing long staple cotton. The export of semi-processed and finished textiles instead of raw cotton increases the domestic value added of raw materials and thus stimulates domestic employment and raises export earnings. The government has recognized the importance of the three sectors by increasing public investment in them. Latest available data presented in Table 5-3 reveal that between 1973 and 1975, total public investment in the three sectors increased by 76.0 percent.

(3) Total Benefits of the Dam's Electric Power

The empirical results of this section are based on two assumptions. First, energy represents the only constraint on the expansion of domestic sectors. All other inputs are assumed to be available at constant prices.

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inverted. Two sectors, coal mining and oil and natural gas were then aggregated, thus reducing number of sectors to 33 sectors. The interflow matrix could be inverted.

6. Robert Mabro and Samir Radwan, The Industrialization of Egypt, 1939-1973. (London: Oxford University Press, 1976), p. 100.

Table 5-3 Public Investment in Selected Key Manufacturing Sectors, 1973-75, (in million LE)

	1973	1975	Percentage Increase
Spinning and Weaving	30.4	47.4	55.9
Food Processing	15.2	38.1	150.0
Chemicals	23.1	35.4	53.0
Total	68.7	120.9	76.0

Source: National Bank of Egypt, Economic Bulletin, Vol. 28, 1975, p. 394.

Second, the government continues its policy of encouraging industrialization by charging industry for electric power at cost of production. This practice is common in many developing nations in their early stages of industrialization. It would seem that the higher the price of electricity, ceteris paribus, the greater the dampening of the demand for new plant and equipment. To the extent that productivity gains are embodied in new plant and equipment,[7] higher priced electricity may slow the increase in productivity and the rate of economic growth.

(i) Balanced Growth

As stated in Chapter 3, a balanced growth strategy allocates the Dam's electric power among domestic sectors, according to the relative contribution of each to total final demand. The 1970 I-O table reveals that the output of the electric power sector needed to support the final demand (LE 2,795.9 millions) of all sectors totalled LE 62.3 millions (at producer's cost). From our empirical analysis in Chapter 4, we estimated the actual cost of electric power generated by the Dam to be LE 8.5 million. The latter amounts to a 13.64 percent increase in total electric power available to the economy. According to equation (11) of the model, i.e., $\gamma x_1 = \sum_{j=1}^{n} z_{1j} \gamma d_j$,

7. See Jan Magnus, "Substitution between Energy and Non-energy Inputs in the Netherlands. 1950-1976", International Economic Review, Vol. 20, No. 2, 1979, pp. 464-484.

and our second assumption above, this LE 8.5 million of additional electric power can support a 13.64 percent across-the-board increase in the final demand of all sectors compared to their levels in the 1971 I-O table. This increase in final demand is calculated to be LE 368.472 million. See Table 5-4.

The increase in total output required from all domestic sectors to produce this additional final demand is LE 649.547 million. We arrived at this figure from equation (13),

$$\Delta x_j = \Sigma\ z_{ij}\, \gamma\, d_j = \gamma x_j ,$$

i.e., by multiplying the new vector of final demand by the inverse matrix. The corresponding increase in employment is 769,400. The major gain to the economy is the increase in payments to primary factors of production, i.e., the increase in national income, which amounts to LE 346.740 million. The gains in both employment and national income are estimated by applying labor-output and value-added coefficients, respectively, to the new vector of gross sector output (see equation 14 and 15). The second gain to the national economy is the gains from net exports. They yield a surplus in the balance of payments of LE 21.15 million.

The results of our calculations are summarized and presented in Table 5-4. The table indicates that agriculture and three agro-based industries (food processing,

Table 5-4 Total Benefits from the Additional Electric Power of the Dam Under Blanced Growth, Egyptian Economy, (000 LE)[a]

Sector	Final Demand (Δd_j)	Gross Output (Δx_j)	Employment (ΔL_j)[b]	Value Added (ΔV_j)	Imports (ΔM_j)	Exports (ΔE_i)
Food Processing	88,051	108,035	12,96	16,637	10,263	6,590
Spinning and Weaving	28,188	55,319	28.76	17,868	3,098	9,681
Pressing and Ginning	16,513	26,173	6.54	2,931	26	22,325
Chemicals	8,716	17,864	6.25	8,449	2,429	947
Construction	31,560	33,458	49.85	15,725	2,074	0
Metallic Industries	2,947	6,006	3.42	2,462	739	138
Agriculture	38,245	142,631	456.00	101,981	4,136	3,280
Iron and Steel	1,186	12,063	3.50	4,451	2,002	651
Transportation	18,527	32,274	51.32	20,978	3,356	419
Subtotal	233,933	433,823	695.60	191,482	28,213	43,131
All Other Sectors	152,539	215,725	170.80	155,258	13,097	19,242
Total	386,472	649,548	769.40	346,740	41,220	62,373

a) d_j of all sectors is 13.64 percent more than than the original levels in the 1971 I-O table.

b) Employment in thousand man-years.

spinning and weaving, ginning and pressing) are the sectors that will continue to dominate the economy. These four sectors account for 65.5 percent of the total gains in employment. The share of the agriculture sector alone is 59.2 percent. The 65.5 percent gain in employment far exceeds the 40.2 percent contribution of these sectors to the increase in national income. It is also clear from the table that expansion of both food processing and agriculture impose a burden on the balance of payments. In contrast, spinning and weaving, and ginning and pressing generate net exports. The latter sector accounts for 35.8 percent of total exports.

(ii) Unbalanced Growth

Under unbalanced growth, full utilization of the additional electric power of the Dam also occurs, but explicit changes are made in the final demand pattern of domestic sectors as compared to their patterns under balanced growth. Two different unbalanced strategies are examined. The first emphasizes the six key sectors with the strongest backward linkages (group one in Table 5-2), hereafter called unbalanced policy I. The second emphasizes the six key sectors with the strongest forward linkages (group two of Table 5-2), hereafter called unbalanced policy II. In each case, all the other domestic sectors are considered nonessential.

As stated in Chapter 3, in order to accelerate economic growth, the government plan is to increase the final demand of nonessential sectors by a lower percentage (α) than under balanced growth. Then the increase in the final demand of key sectors from full utilization of the additional electric power (γx_1) is given from equation (19), i.e.,

$$\gamma x_1 = \sum_{j=1}^{s} (\gamma - \alpha)\, z_{1j}\, d_j + \sum_{s+1}^{n} (\gamma + \beta)\, z_{1j}\, d_j \ ,$$

where j = 1,...,s, nonessential sectors, j = s+1,...,n key sectors, and j = 1 is electricity sector. The increase in key sectors final demand is by a greater percentage (β) than the balanced growth. For any given α , the corresponding β can be calculated from equation (19) as follows:

$$\beta = \alpha \sum_{j=1}^{s} z_{1j} d_j \Big/ \sum_{j=s+1}^{n} z_{1j} d_j \ , \text{ where } \sum_{j=s+1}^{n} z_{1j} d_j$$

is the use of electricity by key sectors under balanced growth and $\sum_{j=1}^{s} z_{1j} d_j$ is the use by all other sectors. In order to calculate β for any given α , we first must calculate the use of electricity by the two groups of key sectors under the balanced growth. This use is presented in Table 5-5 below.

Let α be set at 10 percent of the 0.1364 increase in final demand resulting from balanced growth, i.e., α = .01364. Then the final demand of nonessential sectors will increase by only .12276 d_j, as follows:

Table 5-5 Total Use (Direct and Indirect) of Electric Power from the Dam by Key Sectors Under Balanced Growth (000 LE)

Group One		Group Two	
Food Industry	619.1	Food Industry	619.1
Spinning and Weaving	378.6	Spinning and Weaving	378.6
Pressing and Ginning	69.3	Agriculture	116.3
Chemicals	708.0	Chemicals	708.0
Construction	475.1	Transportation	370.5
Metallic Industries	150.8	Iron and Steel	46.6
Subtotal	2,400.9	Subtotal	2,239.1
All Other Sectors	6,186.8	All Other Sectors	6,348.6
Total	8,587.7	Total	8,587.7

$(\gamma-\alpha)d_j = (.1364 - .01364)d_j = .12276\ d_j$. The reduction in final demand by this given α will mean less electric power is used by these nonessential sectors as compared to balanced growth. If this released electricity is directed toward the key sectors, it will support an additional β percent increase in their final demand.

Using the data given in Table 5-5, β for the key sectors of unbalanced policy I, i.e., those with the strongest backward linkages, is .0351, calculated as follows: $(\frac{.03164 \times 6187.8}{2400.97})$. The increase in final demand of the key sectors is given by 0.1715 d_j, which is derived from $(\gamma+\beta)d_j = (.1364 + .0351)d_j$. If instead the released electric power is directed toward key sectors according to unbalanced policy II, i.e., those with the strongest forward linkages, β is .0386, calculated from $(\frac{.01364 \times 6438.6}{2239.16})$. In this case there will be an increase in the final demand of the key sectors of 0.175 d_j , derived from $(\gamma+\beta)d_j = (.1364 + .0386)d_j$. To summarize, if unbalanced policy I is chosen, the Dam's electric power can support a 17.15 percent increase in final demand for the first group of key sectors, and if unbalanced policy II is chosen, a 17.50 percent increase in the final demand of the second group of key sectors. In either case, the final demand of all other sectors increases by only 12.276 percent.

With these percentage increases in final demand of key and nonessential sectors, a new vector of gross sector's output under both unbalanced strategies is calculated by multiplying the new vectors of final demand by the inverse of the 1971 I-O table as stated by equation (22) of Chapter 3. The result is the expected increase in the gross output of all domestic sectors. Gains in terms of the increase in national income, employment and net foreign earning are calculated following the same procedure used for the balanced growth strategy. The empirical results are presented in Tables 5-6 and 5-7.

Comparison of the gains in both tables indicates that unbalanced growth policy II, which concentrates on the key sectors with the strongest forward linkages, yields higher employment and income gains than unbalanced growth policy I. The differences are 174,000 in employment, and LE 42.2 million in income. However, net exports under unbalanced policy I are LE 8.93 million greater than under policy II. The adoption of policy II is justified by its higher gains in employment and income, which offset its smaller gains in foreign earnings.

Next, we must compare the gains of unbalanced growth policy II with those of the balanced growth policy, to determine which is superior. Their gains are summarized from Tables 5-4 and 5-7 as follows:

	Income (000 LE)	Employment (000 man-year)	Net foreign Earnings (000 LE)
Unbalanced Growth Policy II	371,816	948.9	18,370
Balanced Growth Strategy	346,740	769.4	21,150

Table 5-6 Total Benefits from the Additional Electric Power of the Dam Under Unbalanced Policy I, Egyptian Economy, (000 LE)[a]

Key Sectors (Group 1)	Final Demand (Δd_j)	Gross Output (Δx_j)	Employment[b] (ΔL_j)	Value Added (ΔV_j)	Imports (ΔM_j)	Exports (ΔE_i)
Food Industries	110,709	135,760	16.29	20,907	12,389	8,281
Spinning and Weaving	35,441	69,472	36.12	22,439	3,890	12,157
Pressing and Ginning	20,763	32,899	8.22	3,685	33	28,062
Chemicals	10,961	22,141	7.75	10,473	3,011	1,173
Construction	39,682	42,000	62.58	19,740	2,640	0
Metallic Industries	3,706	7,406	4.22	3,036	911	170
Subtotal	221,262	309,678	135.18	80,280	23,346	49 843
Nonessential Sectors						
Agriculture	34,420	128,318	410.00	91,747	3,721	2,951
Iron and Steel	1,068	10,270	3.00	3,790	1,705	554
Transportation	16,674	28,787	45.80	18,711	2,944	374
All Other Sectors	134,047	186,278	180.86	135,077	10,964	16,287
Total	407,471	663,331	774.84	329,605	42,730	70 009

a) d_j of the key sectors with the strongest backward linkages is 17.15 percent more than the original levels in the 1971 I-O table. The d_j of all other sectors is 12.276 percent more.
b) Employment in thousand man-years.

Table 5-7 Total Benefits from the Additional Electric Power of the Dam Under Unbalanced Policy II, Egyptian Economy (000 LE)[a]

Key Sector (Group 2)	Final Demand (Δd_j)	Gross Output (Δx_j)	Employ- ment (ΔL_j)[b]	Value Added (ΔV_j)	Imports (ΔM_j)	Exports (ΔE_i)
Food Industries	112,969	138,530	16.60	21,333	13,160	8,540
Spinning and Weaving	36,115	70,890	36.86	22,897	3,970	12,405
Chemicals	11,185	22,592	7.91	10,686	3,073	1,197
Trans- portation	23,770	41,037	65.25	26,674	4,268	533
Iron and Steel	1,522	14,641	4.25	5,402	2,430	791
Agriculture	49,068	182,924	583.50	130,790	5,304	4,207
Subtotal	234,679	470,614	714.37	217,782	32,205	27,583
Nonessential Sectors						
Construction	28,404	30,064	44.97	14,130	1,836	0
Metallic Industries	2,653	5,301	3.02	21,730	652	122
Ginning and Pressing	14,862	13,549	5.90	2,637	24	20,087
All Other Sectors	134,047	201,168	180.64	135,130	10,964	16,287
Total	414,645	730,696	948.90	371,816	45,708	64,079

a) d_j of the key sector with the strongest forward linkages is 17.5 percent more than the original levels in the 1971 I-O table. The d_j of all other sector is 12.276 percent.

b) Employment in thousand man-years.

These figures indicate that unbalanced growth policy II will maximize both income and employment gains. Its ability to generate income and create job opportunities (man-years of employment) exceeds that of balanced growth by LE 25.08 million and 179.5 thousand, respectively. However, under policy II, net exports are lower, but only negligibly (by LE 2.78 million).

The higher gains from policy II resulted from the different allocation of electric power as compared to balanced growth. Under the balanced growth, the total use of electric power by the six key sectors of policy II comes to LE 2,239 thousand (see Table 5-5). Under policy II, the same six key sectors consumed LE 2,867 thousand of electricity, or LE 628 thousand more. Every 1 LE of electric power reallocated to these key sectors under policy II means a net drop in foreign earnings of LE 4.39, but an increase in national income of LE 39.8 or nine times as much. Moreover, as compared to balanced growth, policy II creates one additional man-year of employment for each LE 4 of electric power diverted from nonessential sectors. We conclude, therefore, that the unbalanced growth strategy that emphasizes the expar-ion of key sectors with the highest forward linkages definitely maximizes the gains from the electric power of the Dam as originally hypothesized.

(4) Total Benefits of Agricultural Net Output

(i) Income

The net output of the farm sector resulting from the additional water supply of the Dam was estimated in the previous chapter to be LE 152.8 million annually, or 12 percent of 1974 national income originating in the agricultural sector (LE 1,280 million). Most of this increase comes from subsistence crops such as rice, maize and other cereals used primarily for final consumption. An equal increase in farm income is the direct benefit of this additional net output. The lack of any reliable recent figures on the distribution of land holdings or farm income makes it difficult to determine to which groups of the rural population this income will accrue. However, because a third (33.7 percent) of the additional net output is from the newly reclaimed land mentioned earlier, it is expected that landless peasants, the poorest members of the rural population, will receive a substantial part of this direct increase in farm income. Government practice has been to distribute newly reclaimed land to such farm workers. This transfer should increase the productivity of farm labor by raising the land-labor ratio; reduce the inequality in the distribution of the agricultural income; and increase the money wages of farm laborers. The last is likely because of the relative drop in landless farm workers.

The income multiplier of the agricultural sector is needed to derive the indirect benefits of the increase in farm income. This multiplier is calculated from the inverse matrix of the 1971 I-O table and equals 1.32. The direct increase in farm income of LE 152.8 million will induce an indirect increase of LE 48.9 million. Most of the indirect increase in income is generated in the sectors with which agriculture has strongest linkages. These sectors are ones whose markets depend upon agriculture, namely chemicals, transportation and services.

(ii) Employment

The agricultural sector in Egypt is generally cited as a classical example of substantial underemployment. Mead argues that the steady drop in the land-labor ratio is evidence of this phenomenon.[8] The magnitude of underemployment can be estimated from the finding of the Institute of National Planning that 31.2 percent of the farm labor force in 1964/65 was surplus[9] and from Issawi's conclusion that 4.55 feddans of cropped acreage is required to support one man-year of full employment.[10] In 1974 there were 10.743 million feddans of cropped land

8. Donald C. Mead, Growth and Structural Change in the Egyptian Economy. (Homewood, Illinois: Richard D. Irwin, 1967), Chapter 4. A number of economists have doubted whether the theory of surplus labor in agriculture actually applies to Egypt; see for example, Bent Hanson and Girgis Marzouk, Development and Economic Policy in the U.A.R. (Egypt). (Amsterdam: North-Holland Publishing Co., 1965).

9. See Mostafa H. Nagi, Labor Force and Employment in Egypt. (New York: Praeger Publishers, 1971), p. 174

10. Charles Issawi, Egypt in Revolution and Economic Analysis. (London: Oxford University Press, 1963), p. 33.

employing 4.057 million people. The Institute's figure of 31.2 percent suggests that 1.352 million of these 4.057 million were underemployed; Issawi's 4.55 feddan per man-year suggests as many as 1.796 million.

It is doubtful that the introduction of high yield crops, or the changes in crop patterns will significantly reduce the magnitude of this underemployment because the increased need for farm labor is marginal. In contrast, additional land is more likely to have a sizable impact on the number of surplus workers. The availability of water from the Dam permitted the cultivation of 1.550 million more cropped feddans (1.04 million from newly reclaimed land and 510 thousand from perennial irrigation). Using the land-labor ratio of 4.55 feddans above, this additional farm land can support the full employment of only 342,000 more farmers. These direct employment benefits represent 19.0 percent of the 1,796,801 and 25.3 percent of the 1,352,300 underemployed members of the farm labor force in 1974.

The 342,000 reduction in surplus farm labor will add 130,000 man-years of employment to other sectors of the economy. An employment multiplier of 1.38 (see equation 27) has been used for this computation. Most of the indirect gains in employment will occur in the same sectors that are expected to experience the indirect gains in income (chemicals, transportation and services).

These sectors have much higher percentages of skilled workers in their work force than agriculture. Therefore, while the direct employment benefits in agriculture may reduce the severity of underemployment in that sector, the indirect employment benefits will enrich the skill composition in others.

CHAPTER VI

REGIONAL ECONOMIC IMPACTS

As we stated in the first chapter, construction of a large infra-structure project, such as the High Dam, can stimulate economic development during its gestation period as well as afterwards. The investment outlays during the gestation period may have spread effect just as the economic benefits of the completed Dam can have. In this chapter, we will examine the magnitude of the spread effects during the construction period and anticipate the potential economic impact that will follow. Even though we are forced to limit our empirical analysis to the gestation period because of the lack of data after 1970, we still are able to reach conclusions about the prospective economic growth in the region resulting from the construction of the Dam.

Different techniques can be used to analyze the spread effects of external economic forces upon depressed regions. Among these are: input-output analysis, multiplier analysis, and location theory. Multiplier analysis is more applicable for the impacts upon regional employment and income of industrial development projects over a long term period rather than the impacts during the relatively short gestation period of infra-structure projects. Input-output is the most widely used technique[1], but its application to Aswan would require regional input-output table.[1] Unfortunately, this does not exist and constructing one from the very limited available data would be almost impossible. It is not valid to assume that national input-output coefficients hold for the region (as stated in Chapter 2). In addition, in the case of the Aswan region, as will become clear from our analysis only a few industries dominate the region's manufacturing sector; out of manufacturing, mining and agriculture are the main activities. Instead, our study relies upon location theory as well as such techniques, shift share, indices of income dispersion and specialization and multivariate analysis.

The regional economic impacts of the expenditures on the construction activities are examined in terms of population change, degree of urbanization, geographic mobility of labor, per capita income, labor force, employment, skill composition and industrial structure. The latter refers to the expansion of existing industries and the appearance of new ones; the future potential of these industrial developments will also be explored.

(1) Population

Prior to the construction of the Dam, the Aswan region was a border area whose main economic activity was

1. See for example, Robert L. Canion and Warren L. Trock, op. cit.. Also, Walter Isard and Thomas W. Langford, Regional Input-Output Study. (Cambridge, Mass.: M.I.T. Press, 1971), especially Chapter 14.

subsistence agriculture. Stagnation in agriculture and the absence of an economic base explain the extreme economic backwardness of the region compared to the rest of Egypt. During the construction period (1960-1970), the region share of total national investment was far higher than its share of population would suggest.

The first five year plan (1960-1965) earmarked 12.8 percent of total national investment to the region, although its population amounted to only 1.5 percent of national total. In the second five year plan (1965-1970), the region's share increased to 14.8 percent.[2] Construction of the Dam itself accounted for this disproportionately large per capita investment.

This investment led to a swift growth in the region's population, far beyond what can be explained by natural increase. Table 6-1 shows that in the 13-year period preceeding construction (1947-1960), the region's population increased by only 94.6 thousand. This amounts to an annual compound rate of 2.19 percent, only somewhat lower than the national average of 2.4 percent. In contrast, in the 10 year construction period (1960-1970), the region's population rose by 265.7 thousand, almost three times the increase of the prior 13 years. The annual compound rate of population growth more than doubled; it increased to 5.38

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2. Fayez G. Farag, "Rural Community Development in Aswan, A. R. Egypt", unpublished M.A. thesis, Reading University, England, 1972, p. 10.

percent, about double the national average of 2.58 percent, also population density increased by 46.1 percent over the same period. If we assume that in the absence of the Dam, the region's population would have continued to grow at its 1947-1960 rate, the region's population would have been 513 thousand by 1970. The increase associated with the Dam would then amount to 138 thousand, or 51.9 percent of the region's population gain.

Table 6-1 Population and Population Density, Aswan Region, Selected Years

Year	Total Population (000)	Population Density (per km^2)
1947	290.8	546
1960	385.3	723
1966	520.6	845
1970	651.0	1,056

Sources: 1) For population, CAPMS: Population Census, 1947, 1960 and 1966; Population Estimates for 1970.
2) For population density, Aswan Governorate, Statistical Agenda, 1972.

A large proportion of the region's population increase comprised those of school age (5-19 years old). They constituted 89.7 thousand, or one third, of the total increase of 265.7 thousand. An immediate effect of this increase in youth was a large expansion of educational services. Total enrollments in primary and preparatory schools almost doubled (increasing from 41.2 thousand in 1960 to 81.5 thousand in 1970). Secondary and vocational education enrollments increased from 2,876 to 9,917, or by 244.9 percent during the same period.[3]

This large gain in the region's population caused an expansion of the local market for all sorts of goods and services. This process may eventually result in permanent structural changes in the regional economy. A large and diversified local consumer market may continue to stimulate the expansion of business in the region, and thus stimulate supplier industries which will enhance regional development.[4] The investment in human capital, also a part of the overall investment during the construction period will have a long run impact only if there are adequate employment opportunities. However, stimulation of the local economy leading to growth may provide these jobs.

(2) Urbanization

Rapid expansion of the regicn's capital city Aswan, the largest urban center, occurred in the decade of the

3. Aswan Educational Directorate, Yearbook of Education Statistics, 1960 and 1970, Aswan, Egypt.
4. For the effect of population on regional growth, see Harvey Perloff and Lowdon Wingo, Jr., "National Resource Endowment and Regional Economic Growth" in John Friedman and William Alanso, ed., Regional Policy: Readings in Policy and Applications. (Cambridge, Mass.: The M.I.T. Press, 1975) pp. 307-331.

sixties. Between 1960-1964, the Aswan city popul.tion more then doubled, and over the span of the construction period, the city's population more than quadrupled, increasing from 48.4 thousand in 1960 to 206.3 thousand in 1970. The concentration of new job opportunities in and around the capital given the relatively fixed amount of arable land in the region, accelerated the traditional rural-urban migration flow. Consequently, there occurred a marked shift in the distribution of the region's population between its rural and urban sectors. Between 1960 and 1970, the rural population of the region declined from 71.5 percent to 60.4 percent.

This rapid growth of the urban sector in the region, principally in its capital, cannot be attributed to industrialization, but rather to latter's proximity to the Dam's construction site.[5] As discussed below, the site attracted inmigrants from both outside and inside the region. The economic burden of this rapid urbanization in Aswan hampered

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5. The relationship between the degree of industrialization (measured by the percentage of the labor force in manufacturing) and the degree of urbanization (measured by the percentage of urban population) is tested by the following simple linear regression for the period 1947-1971:

$$U = \underset{(2.45)}{24.8} + \underset{(0.925)}{1.16}\ Ind \qquad R^2 = .125,\ F = .856$$

where U is degree of urbanization and Ind. is degree of industrialization, t-ratios in parentheses. The correlation coefficient (R^2) between the two variables is evidently very low, and the industrialization variable is insignificant at the 0.05 level.

the region's economic growth. The need for less immediately productive expenditures on social overhead services drew upon the scarce resources of the region.

(3) Geographic Mobility of Labor

Until the early sixties, the Aswan region experienced a substantial net outmigration. Based on the Population Census of 1947 and of 1960, net migration amounted to -8.4 and -11.4 for these two years respectively.[6] The destination of the region's outflows did not seem to be influenced by distance; it was limited chiefly to Cairo and Alexandria[7], the two largest urban agglomerations in Egypt. Based on the Population Census of 1947 and 1960, these two urban centers combined received almost four-fifths of region's population outflows in both years. The attractiveness of Cairo and Alexandria is explained by the potential availability of employment in their expanding informal service sectors; and presence of relatives who had migrated earlier.

During the 1960's, the construction of the Dam and related facilities created large number of a variety of jobs. The result was a reverse in migration movements,

6. Net migration was estimated for each year by the difference between Aswan residents born elsewhere and Aswan natives residing elsewhere as a percentage of the region's population.
7. For more analysis of population movements in Egypt, see Michael J. Greenwood, "The Determinants of Labor Migration in Egypt", Journal of Regional Science, Vol. 9, No. 3, 1969, pp. 283-290.

and the region began to experience a heavy inflow of migrants. In 1966, the net migration between the Aswan region and the rest of the country is estimated at +2.1 percent. Most of those who migrated to Aswan during this period came from the contiguous rural regions, of Kena and Sohag. These migrants normally had moved north to Cairo and Alexandria. Table 6-2 shows that inhabitants of Kena and Sohag comprised 71.6 percent of all inmigrants to urban areas of the Aswan region during the period 1960-1966.

Table 6-2 Absolute and Percentage Change in the Aswan Region's Residents Born Elsewhere (1960-1966)

Place of Origin	Net Inmigrant Absolute	Percentage
Cairo and other northern urban areas	6,939	15 1
Rural north	3,245	7.1
Rural South (except Kena and Sohag)	2,832	6.2
Kena and Sohag	32,938	71.6
Total	45,954	100.0

Source: Calculated from Population Census of 1947 and 1960, CAPMS, Cairo.

This high percentage of inmigrants from two rural governorates (Kena and Sohag) to urban Aswan can be explained by two factors. One was the rapid increase in the demand for unskilled labor due to the growth of construction jobs paying relatively high wages. The other was the existence of large numbers of friends and relatives in Aswan, which fosters chain migration. They act as informal channels of labor market information for people in their places of origin, and they reduce financial and psychic barriers to migration by helping newcomers to find jobs and adjust to the new social environment.

This phenomenon is sometimes referred to as "social distance"[8]. To test the significance of this factor, the "stock of migrants"[9] in urban centers of the Aswan region is introduced as an explanatory variable in the following nonlinear inmigration function:

$$M_{iA} = c \; S_{iA}^{\alpha} \cdot \left(\frac{w_A}{w_i}\right)^{\beta} \qquad \text{where } i \neq A$$

or

$$\log M_{iA} = c + \alpha \log S_{iA} + \beta \log \left(\frac{w_A}{w_i}\right) + \varepsilon_{iA}$$

The variables are:

M_{iA} : flow of inmigrants from i region to urban Aswan between 1961-1966.

8. Edgar Hoover, An Introduction to Regional Economics. (New York: Alfred A. Knof, 1971), p. 172.
9. See Michael J. Greenwood, "Lagged Response in the Decision to Migrate", Journal of Regional Science, Vol. 10, No. 3, 1970, pp. 375-384.

S_{iA} : stock of migrants from i region in urban Aswan prior to 1961.

$\frac{W_A}{W_i}$: relative nonfarm wage rate, as a proxy variable for income differentials resulted from the expenditures on the construction of the Dam.

ϵ_{iA} : is the random error term.

Both independent variables are expected to take positive sign. The figures in parantheses are t values. The equation is estimated from 20 cross-section observations. The result of the regression is:

$$\log M_{iA} = -3.21 + 1.43 \log S_{iA} + 2.05 \log(\frac{W_A}{W_i})$$

$$(-1.69) \quad (4.69) \qquad\qquad (1.61)$$

$$R^2 = .58, \ F = 11.61 \ .$$

As expected, both variables took the positive sign. However, the stock of prior migrants would seem to be a stronger influence than wage differentials in explaining inmigration flows to the urban sector of the region. The stock of prior migrants is found to be significant at the 5 percent level, the wage differential is signifncant at only the 10 percent level.

(4) Per Capita Income

Industrialization under the First Industrial Plan (1957) was almost entirely confined to few urban centers in the north. This concentration continued the existing dualism. In terms of per capita income, Cairo and Alexandria remained the leading regions, while all the southern regions still lagged behind. In 1960, per capita income in Aswan region was only 55 percent of that in Cairo (LE 47 compared to LE 85).[10] During the 1960's, the direct and indirect effects of public expenditure on construction of the Dam helped reduce this gap. Based on our own estimate, over the 1960-1970 period, per capita income in Aswan increased by 51 percent compared to only 20 percent in Cairo (per capita income is estimated at LE 101.98 for Cairo and LE 71.04 for Aswan in 1970).[11] The income dispersion index between the two regions also declined from 0.15 in 1960 to 0.108 in 1970.[12] These empirical findings suggests that a development policy which pursues a geographical dispersal of public investments helps

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10. Abou-Baker Metwalley, Regional Aspects of the U.A.R.'s Economic Development, Ph.D. thesis, Roterdam, n.p., 1970, p. 85.
11. Regional per capita income is estimated as follows. Regional income of sector j = $Y_{Lj} \times L_j$

$$\text{Region's per capita income} = \sum_{j=1}^{n} \frac{Y_{Lj} \times L_j}{N}, \text{ where}$$

Y_{Lj}: average income per worker in sector j; L_j: total employment of sector j; N: region's population.
12. Income dispersion index is measured as follows:

$$I_w = \frac{\sqrt{(Y_A - Y_C)^2 \frac{P_A}{P_C}}}{Y_C}$$

Y_A: per capita income in Aswan region.
Y_C: per capita income in Cairo.
P_a: population of Aswan region.
P_c: population of Cairo.

Use of this formula was inspired by reading Jeffrey reduce regional income inequalities. However, our conclusion should be treated with caution, because data showing the continuation of this trend after completion of the Dam in 1970 are lacking.

(5) Employment and Labor Market Conditions

The creation of more job opportunities during the period 1960-1970 is among the main contributions of the Dam. In this section we will quantify the magnitude of the employment gains. Here, shift ratio analysis is used to indicate the pattern of sectoral changes. A basic assumption of this technique is that in the absence of the project, the relative change in employment among different sectors would change in the region just as the rest of the nation between 1960 and 1970. The difference between acutal distribution of employment in 1970 and that estimated by shift-share analysis indicates the amount of regional diversity that occurred.

Table 6-3 presents employment by sector for 1960 and 1970. The table shows that construction of the Dam created (directly and indirectly) 23,360 jobs in the region over the period 1960-1970. The combined share of construction and mining (a source of raw material for the Dam) in total regional employment increased from 9.2 percent

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G. Williamson, "Regional Inequality and the Process of National Development: Description of Patterns", in Friedmann and Alanso, eds., op. cit., pp. 158-200.

Table 6-3 Distribution of Employment by Economic Sectors, Aswan Region, 1960 and 1970

Economic Sectors	Actual Employment 1910	Actual Employment 1970	National Percentage Change (1960-1970)	Regional Estimated Employment Using National Percentage Change	Difference Between the Actual & Estimated Employment in 1970 (4) - (2)
Agriculture	55,852	64,100	11.7	62,400	1,700
Mining	1,010	7,700	45.4	1,470	6,230
Manufacturing	6,780	13,200	83.7	12,450	750
Construction	7,860	13,000	33.7	9,430	3,570
Public Utilities	1,620	1,000	56.2	2,540	-1,540
Commerce	5,420	13,000	18.0	6,390	6,610
Trans-portation	4,120	4,600	46.0	6,010	-1,410
Services	13,310	21,800	7.8	14,350	7,450
Total	95,972	138,400		115,040	23,360

Sources: CAPMS, Population Census of 1960.
CAPMS, Employment Sample Survey of 1970.
Ministry of Planning, Population and Its Social Consequence on Development in UAR.

in 1960 to 14.9 percent in 1970. Most of this growth took place in the five years of heavy construction from 1961-1966. The sectors experienced the fastest employment expansion between 1960 and 1970 were commerce (139.9 percent), manufacturing (94.7 percent), and services (63.8 percent). The growth in commerce and to a lesser degree in manufacturing well exceeded that of the region's 68.9 percent gain in population. The increase in commerce was induced by the increase in population, particularly in the capital city of Aswan. However, much of the new commercial activity was not particularly productive. In Aswan, as in many developing regions, much retail is actually peddling, requiring little skill and capital. Many of the newcomers engaged in commerce activities can be classified among the disguised unemployed. In contrast, the incidence of disguised unemployment probably was far less in services, which includes education, health and government administration.

The absolute decline in public utility employment (38.3 percent) and the negligible increase in transportation employment are difficult to explain. The modest expansion in agriculture was mainly due to the irrigation of 30,000 more feddans of land in the region after 1966 when additional water became available from the Dam. The decline in its share in total employment from 58.2 percent to 46.3 percent (excluding labor of children 6-15 years old) may indicate a slow industrialization process at work.

The percentage of high level manpower (professionals and managers) in the labor force increased from 3.5 percent in 1960 to 5.4 percent in 1970. The percentage of those with 15 years or more of formal education grew from 4.8 percent to 7.9 percent. The proportion of illiterate remained high although it declined (from 67.2 percent to 62.8 percent). These changes reflected the heavy in-migration of uneducated rural workers, on one hand, and the inflow of educated personnel to manage and execute the construction of the project, on the other hand.

Regional unemployment rates shows no meaningful improvement; in fact that worsened. Table 6-4 shows that the unemployment rate declined from 1.4 percent in 1960 to 0.7 in 1964, but then increased to 8.4 percent in 1970. Nonetheless, official unemployment figures ignore under-employment and the discouraged workers and thus do not reflect the true state of affairs in the labor market.[13] As an indication of the extent of underemployment, wage earners constitute less than half of the regional labor force. A suggestion of the large number of discouraged workers is given by the relatively low labor force participation rates of only 34.4 percent and 39.1 in

13. See M.C. Dantwala, "Unemployment and Problems in Its Measurements in Developing Countries", in Challenge of Unemployment to Development and the Role of Training and Research Institutes. (Paris: OECD, 1971), pp. 30-31.

Table 6-4 Population and Labor Force, Aswan Region, 1960, 1964 and 1971 (000)

	1960	1964	1971
Population	385.5	469.0	651.0
Active Population (AP)	314.5	385.3	411.0
Labor Force (LE)	108.2	117.7	161.0
Employed	106.6	116.8	147.5
Unemployed	1.6	0.9	13.5
Labor Force Participation Rate (LFPR)	34.4%	30.5%	39.1%
Official Unemployment Rate	1.4%	0.7%	8.4%
Estimated Unemployment Rate	16.5%	19.1%	20.7%

Source: For 1960 figures, see Table 6-3. For 1964 and 1971, CAPMS, Employment Sample Survey of 1964 and 1971. Estimated unemployment rates are obtained as follows:

$$\frac{\text{Unemployed + 10\% of AP not in LF}}{\text{LF + 10\% of AP not in LE}}.$$

1960 and 1971, respectively. However, the conclusion is marred by the omission from the labor force of unpaid family workers in agriculture. Still, if we assume that an additional 10 percent of the active population wanted to work, the unemployment rates would have been 16.5 percent and 20.7 percent in 1960 and 1971 respectively.

These findings infer that while official unemployment rates did not change much, hidden unemployment increased substantially. The construction of the Dam attracted more people than the jobs it created, imposing on the area the need for social services that the public sector could not provide.

(6) Industrial Location and Future Development Potential

This section examines whether construction of the Dam led to a significant increase in the region's industrial activities. The hypothesis is that public investment in the region's economy will improve its comparative advantage in specific manufacturing activities. If these industries are found to have strong linkages, they might provide the core of a growth pole within the region. In addition to manufacturing, mining is also included because of its importance to the regional economy.

Our analysis relies upon two quantitative measures, namely, the location quotient and the coefficient of specialization. The first identifies basic and non-basic industries by comparing the concentration of industry i in the region and the nation.[14] The second determines the degree of regional specialization by measuring the extent to which the distribution of employment among the region's different manufacturing activities deviates from that of the entire economy.[15] Although it would be preferable to cover the 1960 decade, absence of consistent data for regional industries after 1966 forced us to limit our analysis to the period 1960-1966. Nevertheless, conclusions about the nature of the region's industrialization and the effect of the Dam's construction on this process can still be reached.

Industries in which the region is most specialized are presented in Table 6-5. The remarkable rise in the location quotient of mining and quarrying between 1960 and 1966 is attributed to the construction of the Dam and related activities, such as housing. These activities stimulated the demand for granite, rocks and quartz; as a result, employment in mining and quarrying increased by 331 percent (from 1,010 in 1960 to 4,355 in 1966). The Dam also increased the demand for the products of non-metallic manufacturing industries such as cement and brick, although here the increase in employment was relatively moderate.

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14. Walter Isard, Methods of Regional Analysis. (Cambridge, Mass.: M.I.T. Press, 1976), pp. 123-126.
15. Hoover, *op. cit.*, pp. 211-212.

Table 6-5 Location Quotients for Basic Industries, Aswan Region, 1960 and 1966

Industry	1960	1966
Mining and Quarrying	4.2	11.6
Food Processing	1.7	2.4
Paper Products	0.0[a]	2.1
Chemicals	17.1	31.7
Nonmetallic Manufacturing	0.8	1.8

Sources: The coefficients are calculated from data compiled from CAPMS, Population Census of 1960; Industrial Survey of 1966/67.
a) No employment, new industry.

Chemicals (chiefly fertilizers) is found to be the most important basic industry in the region. Its location is explained by the region's comparative advantage because of the supply of raw materials especially phosphate used to manufacture artificial fertilizers. The other major input is electrical power. Both inputs could not economically be brought in from elsewhere. The close to doubling of the location quotient of chemicals can be explained by a gradual increase in production from a single plant built in 1959. As noted earlier, this plant still relied for its power upon a hydroelectric plant constructed in 1961 on a dam dating back to the late 19th century.

The position of food processing reflects the presence of the two largest plants in Egypt for the crushing and refinery of sugar cane, one of the region's main agricultural products. However, rise in the food-processing location quotient is due only indirectly to the Dam. During 1960-1966, the increase in the region's urban population resulted in an expansion of local consumer demand for the output of new small-scale food processing enterprises in the dairy products, flour milling and baking industries. In contrast, the new paper industry which appears in 1966 is the result of the construction of a paper mill designed to convert the byproducts of one of the sugar factories into paper paste and paper products.

The forgoing analysis points out that a few raw material oriented industries dominate the region's mining and manufacturing. It also appears that during the construction of the Dam, there was an increase in regional specialization in four industries in which the region had already specialized, and the addition of a fifth. The same point is made by the coefficient of specialization, whose value for 1960 and 1966 is 0.39 and 0.45 respectively.

The Dam low cost power, in conjunction with local resources, has the potential of stimulating the industries discussed above so that they will ensure long run regional development. The additional water from the Dam made possible the irrigation of 11,100 feddans of sugar cane.[16] The availability of low-cost power from the Dam and the additional sugar cane production will allow the expansion of the food processing (sugar) and paper pulp industries. Moreover, the Dam created a large man-made lake (4000 km^2) that permitted a substantial rise in the amount of fish caught (15,000 tons in 1975 compared to just 750 tons in 1966). A potential catch of 50,000 tons annually [17] suggest the possibility of establishing a fish freezing and fish canning industry.

Roads built during the sixties and the new

16. Farag, op. cit., p. 66.
17. Aswan Regional Planning Authority, "Economics of Lake Naser Fish Production, Transportation, and Marketing", Technical Report, 1974, p. 13.

possibility of year-round river navigation will make extraction of local mineral deposits economically possible. Local minerals include tin, tungsten and chromium in the Eastern Desert, and Kaolin and clays in the Lake area. However, for mining to become a second strong focal point for regional development will require more than new jobs in the industry. It will also require forward linkages with regional metal and non-metallic industries. Again the availability of a cheap power source makes this process feasible. Phosphate, a key input for artificial fertilizer, is abundant in the region. The low cost energy from the Dam will lead to the growth of local chemical industry because of the exceptionally large amounts of electricity needed in the production of fertilizers. The Ministry of Industry has long suggested the expansion of the chemical industry, but including more than just fertilizers. The Ministry has estimated that 5,563 new jobs would be created.[18]

What empirical evidence is there that sufficient linkages exist among these industries for them to constitute an adequate growth pole. Ideally, the evidence would be the actual transfers of raw and semi-processed materials from one industry to another. In the absence

18. General Organization for Industrialization, Planning Department, Aswan Preliminary Industrial Plan, Cairo, Egkypt, 1972.

of such regional data, we were forced to use the patterns of interdependence in the 1971 national input-output table.

An examination of Table 6-6 displays a high degree of interaction among these growth pole industries (including electric power). It is evident from the table that the linkages of chemicals, paper products and nonmetallic industries within this group are predominantly backward. For example, the combined proportion of direct domestic inputs received by chemical industry from itself, mining, food processing, paper products, nonmetallic and electrical power amounts to 68.7 percent. In contrast, its intermediate output delivered to this group of industries amounts to 35.8 percent. The linkages of mining and food processing are predominantly forward. The substantial forward linkages associated with food processing and this group of industries are due to the use of byproducts from sugar refining by the paper pulp industry. Its relatively low backward linkages is explained by its heavy reliance on agriculture as the main supplier of primary inputs. Based on the 1971 input-output table, 68.1 percent of the food processing industry direct domestic inputs were received from the agricultural sector. Thus, the growth of paper pulp as well as food processing can induce expansion in the agriculture sector. The latter is no longer constrained by an inadequate supply of water.

Table 6-6 Patterns of Interdependence Among the Suggested Growth Pole Industries, 1971

	Percentage of Domestic Inputs Derived from Within This group of Industries and the Electric Power	Percentage of Intermediate Output Delivered to This Group of Industries
Mining	26.6	39.1
Food Processing	20.0	78.9
Paper Products	61.6	23.9
Chemicals	68.7	35.8
Nonmetallic Products	28.1	11.0

Source: Computed from the I-O table of 1971.

These findings indicate that a regional planning strategy that concentrates on the simultaneous expansion of this select group of industries, which we refer to as growth pole is appropriate in view of the likelihood that investment funds for a "big push" to realize the regional full potential of the Dam might never materialize (given the state of the national economy). By emphasizing these industries, this investment strategy may eventually set into motion an upward spiral of development, and the reallocation of unemployed and underemployed farm workers to manufacturing.

Summary

By examining the regional economic aspects of the Dam, our main findings indicate that the region gained in terms of population and employment. Most of the population gain was felt in the capital city, thus imposing the need for less immediate productive social overhead expenditures. Most of the employment gain occurred in construction and mining activities. These two sectors captured 51.9 percent of the total gain in employment. There also occurred a change in the spatial distribution of population and migration trends. The percentage of rural to the total regional population declined from 71.5 percent in 1960 to 60.4 percent in 1970. The direction of migration has been reversed since the beginning of the construction period. The region experienced heavy inflow of migrants, attracted mostly by the relatively higher wages and existence of relatives. Although these inmigratory moves have improved the quality of the region's labor force and skill composition, it worsened the labor market conditions. The Dam attracted more people than the jobs it created; the result was a substantial increase in unemployment and disguised workers.

The public investment in the region's economy had improved its comparative advantage in specific industrial activities. These industries are chemicals, food processing, paper, nonmetallic industries in addition to mining. The availability of required raw material, in conjunction with low-cost power of the Dam, will strengthen the position of these industries. However, full utilization of the Dam's potential would require a regional development strategy that emphasizes their simultaneous expansion. These industries, due to their strong linkages are expected to become the potential growth pole in the region.

CHAPTER VII

SUMMARY AND POLICY RECOMMENDATIONS

The general objectives of this study have now been accomplished; a model measuring the alternative costs and total benefits of the Dam has been presented and applied empirically. Structural changes in the Aswan Region's economy also have been examined. In the first section of this chapter we summarize the major findings of the empirical analysis, and in the second section, make policy recommendations, leaving the task of selecting the most appropriate ones to decision makers. In the final section we suggest further areas for research.

(1) Summary of the Main Finding

a) Based on alternative cost, generation of hydroelectric power by the Dam is found to be economically justifiable. The cost of the Dam's 5 billion kw/h annually amounts to only LE 8.5 million; if conventional methods are used to generate the same amount of electricity, the cost to the economy would be LE 86.8 million. The savings, as measured by the alternative costs, totals LE 78.3 million annually. The conventional methods need 52,866 man-years of employment, primarily semi-skilled and skilled jobs, the labor for which is in relatively short supply and has to come from other sectors. Moreover, power from the Dam saves LE 9.397 million in potential imports.

b) Total benefits of the Dam's electric power are measured using alternative growth strategies, balanced and unbalanced; both strategies assure the full utilization of the power for intermediate purposes. However, gains in income and employment are maximized under the unbalanced growth strategy which disproportionately assigns the Dam's power to the six key sectors with the strongest forward linkages as suppliers of intermediate inputs.

The gains from this strategy are an increase of LE 731.816 million in national income; of 948.9 thousand man-years in additional employment, and of LE 18.371 million in the balance of payments. These income and employment benefits exceed those from a balanced growth strategy by LE 25.08 million in income and 179.5 thousand in man-years of employment. The surplus in the balance of payments, however, is LE 2.78 million less compared to the balanced growth strategy. The extra gains from unbalanced growth as compared to balanced growth resulted from diverting LE 628,000 of electric power from nonessential sectors to the six key sectors with the strongest forward linkages. Every one LE worth of electric power shifted to these key ctors reduces net foreign earnings by LE 4.39 but adds an dditional LE 39.80 to national income and creates a 25 additional man-year of employment.

c) The Dam's additional water supply permits an increase in net agricultural output of LE 152.8 million annually, at 1974 prices. Without the Dam, these farm products would have been imported at rapidly rising international grain prices, thus worsening the balance of payments problems. Also, the government would have to allocate an additional LE 160.9 million annually for food subsidies to offset the gap between international and domestic grain prices. Food subsidies are needed for economic and political stability. A reduction in food subsidies designed to reduce a deficit in the balance of payments will force low income groups to cut back on "unessential" purchases rather than do without basic necessities. The resulting decrease in economic activity will exceed the reduction in the deficit.

d) The net increase of LE 152.8 million represents the direct benefits of the Dam's water used for irrigation. A third of these benefits will accrue to landless peasants thus helping to narrow income differences in rural areas. This net increase in farm output requires 342 thousand man-years of farm work, reducing the labor surplus in agriculture by between 19 and 25 percent. Based upon income and employment multipliers of the agricultural sector, the indirect benefits of the increase in agricultural production are LE 48.9 million in national income and 130 thousand man-years of employment. Most of these indirect gains occur in sectors with strong forward linkages with agriculture. These are chemicals, transportation and services.

e) Construction of the Dam (1960-1970) attracted to the Aswan region inmigrants from contiguous rural regions as well as accelerated rural-urban migration within the region. The construction also led to an increase in regional per capita income. Total population gains attributed directly to the construction phase amounted to 138 thousand. The population of the region's capital city more than quadrupled, requiring expenditures on social overhead services that were not immediately productive. The construction activities also added 23,360 jobs to the regional employment and slightly improved the skill composition of the labor force. Nevertheless, the construction created fewer jobs than the number of inmigrants it attracted. The result was a substantial increase in underemployment.

The most import structural changes were related to the marked increase in regional specialization in raw-material oriented industries. The construction phase led to the expansion of industries in which the region has had a comparative advantage. The low cost power of the Dam combined with the continuing local availability of raw materials will further stimulate these industries. They are chemicals, food processing and nonmetallic manufacturing. They possess a high degree of interdependency, which suggests that the core of a future growth pole in the region is being formed. This will ensure long run regional development.

(2) Policy Recommendations

a) An energy management plan that aims at the efficient allocation of the Dam's hydroelectric power in order to maximize national economic gains will have to allocate larger shares to the six key sectors identified above. This policy will then call for an economic development plan that gives high priority to the expansion of food processing, spinning and weaving, transportation, chemicals, iron and steel, and agriculture. However, simultaneous expansion of all these sectors cannot be taken at once because of the lack of adequate sources of domestic and foreign capital for investment. A more feasible economic development policy will allocate investment funds for one important project in each of these industrial sectors. Each project should be selected as a "growing point"[1], i.e., an industrial project which in itself stimulates the growth of other industries that use its products.

b) Our empirical findings suggest that under any of the growth strategies that have been examined, agriculture

1. I. Livingstone, "Agriculture versus Industry in Economic Development," in I. Livingstone, ed., Economic Policy for Development. (London: Penguin, 1971), p. 241

and agro-based industries will continue to dominate Egypt's economic development. The expansion of the agricultural and food processing sectors will not directly contribute much to the country's balance of payments. However, the ginning and pressing, and the spinning and weaving of cotton are major sources of foreign exchange. These two sectors contribute more than half of all exports under each of the development strategies examined and depend heavily on agriculture for raw materials.

Moreover, the importance of the agricultural sector in Egypt (as well as in most developing countries) is also due to its being highly labor intensive, while manufacturing is much less so and does not absorb additional labor at rapid rates. Agriculture also possesses a flexible production function, i.e., it permits wide variations in input combinations. The conclusion emerging is that economic development in Egypt can not proceed if the agricultural sector is neglected relative to the manufacturing.

A package of measures needed to assure the development of agriculture should include not only the reclamation of new land in order to fully utilize for irrigation the additional water supplied by the Dam, but also the introduction of the appropriate technology accompanied by adequate training in its use. There also must be water management that includes a pricing mechanism to allocate the Dam's water for irrigation instead of treating the water as a free good. These measures should be accompanied by serious efforts to lower the rate of rural population growth, thus reducing the population pressure on the land and slowing internal migration to densely populated urban areas.

c) The analysis of the localization of economic activities suggests that a regional development plan whose intent is to realize the economic potential of the Aswan region should concentrate on the expansion of the basic industries in which the region already specializes, namely, chemicals, food processing, paper and nonmetallic manufacturing. The linkages of these industries will generate further expansion through external economies. This regional plan should be integrated into the national development plan.

In conclusion, it is evident that the Aswan Dam project should become the main element of future economic development in Egypt. The Dam already has added new resources to the economy but it also has imposed a new set of constraints in the form of industrial sectors that should be expanded in preference to others.

(3) Suggested Further Studies

The alternative costs and benefits of the additional agricultural output resulting from the Dam could not be fully estimated. As indicated in chapter 4, the reasons were the lack of information about the yields and the type of crops grown on the reclaimed land, and land using perennial instead of basin irrigation. The collection of such agricultural data is essential as a guide to the efficient allocation of agricultural investment.

Estimates of the benefits derived from the electric power produced by the Dam relied on the 1971 I-O table in order to identify the key sectors. One year's interindustry relationships is inadequate for determining whether specific sectors indeed are the key ones. I-O tables for other years exist, but cannot be used because of the incompatability of the classification used in different tables. Comparable industrial groupings are vital. Existing I-O tables should be made comparable, and future ones should use the same classification.

The lack of information about sectoral capacity and its utilization also limited our efforts to estimate the benefits from the Dam's electric power and we had to assume that electric power was the only constraint on the expansion of sectors. Other constraints might be sector's production targets, the availability of natural resources, capital, skilled labor, and unused capacity. It would be valuable to explore the implications of a linear programming model using such constraints to determine the optimal solution for the allocation of electric power subject to alternative goals. Among these goals might be maximizing employment, domestic output, or minimizing the need for foreign exchange and capital. Data to design such a model is hard to find; this gap should be filled. In short, a more realistic and hence more useful planning model requires considerably more economic data than is now available as well as the putting of such data in a consistent fashion.

APPENDICES

Appendix A-1

The 1970/71 Input-Output Table. Egypt

The Input-Output table of 1970-71, as constructed by the Ministry of Planning for the Plan Frame of the Egyptian economy, represents the major source of data used in the study. The table consists of 27 sectors; its interflow transactions are measured in 000 LE at 1969-70 producer prices.[1] These prices include cost of production plus tariff, plus excise duties or commodity taxes minus subsidies. Producer price for imports represent imports at c.i.f plus custom duties. The value added is aggregated into a single row, while the final demand is disaggregated into five components: private consumption, public consumption, investment, exports and change in stocks.

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[1] For a detailed explanation about the method of constructing this table and the economic activities included in each sector, see Richard S. Eckaus, Desmond McCarthy, Amer Mohie-Eldin. "Multisector General Equilibrium Policy Models for Egypt". Unpublished Report (Mimeographed). M.I.T., 1978. As for earlier I-O Tables, see Goda, A. Mohamed, "Sectoral Interdependence and Egypt's Investment Strategy", Unpublished Ph.D Thesis, McMaster University, 1974.

Input-Output Table for the Plan Frame 1970/71 in Producer Price (1969-70 Prices) . 000 LE.

Receiving Sectors / Delivering Sector	1	2	3	4	5	6	7	8	9	10	11	12
Agriculture	192856	157700	-	-	404453	1344	-	2426	-	1715	525	-
Gining and Pressing	281	-	-	-	4973	-	-	64985	-	-	-	-
Mining and quarrius	239	-	26	92	157	-	-	-	-	-	-	-
Crude Oil	-	-	-	-	-	-	-	-	-	-	53	-
Food Industries.	15476	-	-	-	112706	3202	52	966	-	-	-	-
Beverages	-	-	-	-	237	91	-	-	-	-	192	-
Cigarettes and tabak	-	-	-	-	-	-	-	-	-	-	-	-
Spinning and Weaving	600	2355	77	73	2857	-	-	-	-	-	-	-
Ready-made Clothes	-	1	-	-	2	-	-	150550	36881	125	55	5
Timber and Cork.	-	-	11	58	525	-	-	52	12	-	-	-
Paper.	-	-	77	61	1494	380	16	-	81	2121	-	-
Printing and publication	-	-	-	-	-	36	1271	2870	162	33	3405	7164
Leather	-	66	-	104	-	-	-	-	-	-	-	-
Rubber	100	-	31	286	-	-	-	-	11952	272	-	4
Chemicals	22682	-	327	552	1151	-	-	121	725	-	-	-
Crude Oil products.	8622	452	570	887	1061	320	176	1618	743	985	345	775
Non-metalic.	-	-	160	539	806	320	97	1520	56	-	316	178
Basic industries.	-	775	158	1161	244	515	-	-	-	228	27	-
Metalic.	1048	8	149	1108	1643	18	798	-	-	490	45	230
Non-electrical.	2901	20	103	998	176	495	-	1469	99	445	44	40
Electrical	-	23	64	702	61	30	6	382	92	-	27	-
Vehicles repairing.	-	-	-	-	-	7	33	806	99	-	29	41
Other industries.	332	-	65	321	-	-	-	-	-	-	-	-
Electricity	200	168	195	350	2638	-	-	211	191	21	-	-
Construction	500	100	100	200	500	105	420	2500	200	903	534	100
Transport and Communication	5518	2173	399	561	9771	100	100	500	100	100	150	50
Other services	15484	6236	435	1156	50072	587	2252	10146	1029	2397	556	511
						1967	3839	10379	3710	2639	1097	647
omestic inputs.	267339	170077	2947	9209	595507	9493	9060	251501	58132	12474	7400	9745
nputs from imports.	37861	923	1553	3991	83793	501	94340	27999	1068	8826	7200	6555
otal Inputs.	305200	171000	4500	13200	682300	10000	103400	279500	59200	21300	14600	16300
alue added.	740080	20830	9875	61888	109305	8475	17510	125588	28625	17655	10473	10200
utput	1045280	191830	14375	75088	791605	18475	120910	405088	87825	38955	25073	31500

ble (1)

Input-Output Table (continued)

3	14	15	16	17	18	19	20	21	22	23	24	25	26	27
	-	614	-	295	-	-	-	-	-	465	-	-	1029	1466
	-	24	-	-	-	-	-	-	-	-	-	-	-	-
	11	1411	-	2401	1982	-	-	-	-	-	-	3884	-	54
	-	-	6694	-	-	-	-	-	-	-	-	-	-	-
4	-	2402	-	-	-	-	-	-	-	-	-	-	365	4791
	-	-	-	-	-	-	-	-	-	-	-	-	202	527
	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	414	918	-	-	-	276	-	423	23	321	-	176	223	2099
	-	5	2	-	3	1	-	4	4	-	-	-	8	470
	16	242	2	34	-	33	57	4	91	143	-	9348	194	3359
0	54	688	10	652	-	141	-	827	143	83	-	-	447	4739
	-	-	-	-	-	-	-	-	-	-	-	-	895	3337
7	-	-	10	-	-	285	38	-	220	973	-	-	-	-
	159	167	14	—	-	173	199	617	1960	—	-	55	3525	1563
1	730	20987	263	537	16	1148	228	2477	1066	609	-	988	497	5874
1	82	1670	9 23	2028	5643	120	154	-	183	54	3025	1394	6035	3706
	-	722	20	2639	613	333	-	1002	434	1372	-	29317	389	394
	36	333	49	819	25764	12308	2985	4255	2041	4161	81	15287	348	476
8	130	328	60	202	158	767	241	2090	4305	938	-	5009	188	560
	16	212	85	108	141	-	595	-	452	-	101	-	257	196
	63	196	78	240	307	79	196	4041	1470	-	246	1966	1217	913
	-	-	-	-	-	-	-	-	2300	-	-	-	10050	3000
	-	-	26	-	36	17	20	503	32	43	4	47	-	613
7	746	8450	191	2800	2176	1510	320	863	461	90	-	62	3760	3340
0	100	400	250	200	150	100	50	100	100	100	200	50	4500	4667
7	380	3531	63	3637	1321	1252	762	577	850	510	3021	2995	6195	39168
8	755	7120	2163	4121	2605	1610	417	1905	2290	207	1376	39326	17787	16315
1	3692	50420	10903	20713	39015	20153	[illegible]	18368	16425	10069	8054	113404	58102	101677
9	5608	21180	13997	7987	17485	6647	4938	10912	17175	2331	6546	18596	32598	60823
0	9300	71600	24900	28700	56500	27000	10200	29800	35600	12500	14600	132000	90700	162500
3	6287	57501	40965	25138	27162	16183	6773	20619	19418	12452	47703	112930	143800	578600
3	15587	129101	65865	53838	83662	43183	16973	50419	55018	24952	62303	244900	234500	741100

Input-Output Table (continued). 000L.S.

Total Intermediate demand	Private Consumption	Public consumption	Investment	Exports	Change in Stocks	Total final demand	Output
764888	262400	5679	-	8233	4030	280392	1045280
70763	365	30	-	120311	361	121067	191830
10358	1580	62	-	2471	96	4017	14375
6694	-	-	-	68394	-	68394	75088
146066	578977	17479	-	45697	3386	645539	791605
1057	14196	-	-	3222	-	17418	18475
-	118131	-	-	2779	-	120910	120910
198431	132207	4315	123	63052	6960	206657	405088
564	63038	6274	-	14073	3876	87261	87825
16715	10643	5237	1445	2500	2215	33340	38955
23787	738	548	-	-	-	1286	25073
4282	18759	7009	-	1450	-	27216	31500
16011	2058	568	-	-	516	3142	19153
9495	3620	2472	-	-	-	6092	15587
65185	50251	8399	-	4678	588	63916	129101
39129	18453	7494	-	459	330	26736	65855
39501	2434	694	2789	6542	1878	14337	53838
74962	-	1350	3950	1350	2050	8700	83662
21572	13630	1775	1958	2000	2188	21611	43183
6898	500	190	9385	-	-	10075	16573
12377	15275	1200	17067	2000	2500	38042	50419
15350	6355	9500	10313	4000	9500	39668	55018
2482	15900	120	1450	3900	1100	22470	24952
(33139)	23164	6000	-	-	-	29164	62303
13517	-	80486	150897	-	-	231383	244900
98669	105224	26607	-	4000	-	135831	234500
158726	376130	71347	21158	73739	-	542374	741100
1890618	1834288	264835	220535	434850	41432	2795940	4686558
509482	45009	114665	70465	-	-	230139	739621
2400100	1879297	379500	291000	434850	41432	3026079	5426179
2285458	-	434300	-	-	-	434300	2720758
4686558	1879297	813800	291000	434850	41432	3460379	8146937

Appendix A-2

The Inverse of the Technical Coefficients Matrix of the 1970-71 I-O Table.

The technical coefficients matrix of the 1971 Input-Output table has been inverted and presented in this Appendix. This matrix was used in the estimation of the alternative costs and total benefits of the electrical power of the Dam; measuring the income and employment multipliers of the agricultural sector;and in calculating the indices of sectoral interdependence for the purpose of identifying the key sectors of the economy. The inverse of the technical coefficients matrix should read 27 rows by 27 columns. The elements of the last row and column, i.e. row 28 and column 28, are the summation of the inverse matrix elements of each row ($\sum_{j=1}^{27} z_{ij}$), and each column ($\sum_{i=1}^{27} z_{ij}$) respectively.

The Inverse of the Technical Coefficients Matrix of the 1970/71 Input-Output Table.

1	2	3	4	5	6	7	8	9	10
1.24201400	1.02497377	0.00339425	0.00162926	0.74972865	0.22507179	0.00127528	0.27788190	0.15353472	0.06296368
0.00137251	1.00431955	0.00156748	0.00040481	0.00933982	0.00198838	0.00006108	0.25659695	0.10839320	0.00117095
0.00074219	0.00079964	1.00352550	0.00264771	0.00088288	0.00240284	0.00033580	0.00055038	0.00095077	0.00149224
0.00118440	0.00134218	0.00461458	1.00163831	0.00103005	0.00251180	0.00027846	0.00125728	0.00086507	0.00073843
0.02238687	0.01899688	0.00131178	0.00118614	1.18037550	0.20906369	0.00101815	0.01040961	0.06108814	0.00577159
0.00003240	0.00006497	0.00005806	0.00002758	0.00044173	1.00515772	0.00004505	0.00009286	0.00013597	0.00013068
0.	0.	0.	0.	0.	0.	1.00000000	0.	0.	0.
0.00185624	0.02137635	0.00966936	0.00245634	0.00847795	0.00312334	0.00033202	1.59779170	0.67254419	0.00673859
0.00001767	0.00004600	0.00003359	0.00001861	0.00006558	0.00009577	0.00002427	0.00025033	1.00029717	0.00006223
0.00027227	0.00045930	0.00153309	0.00120734	0.00146631	0.02319111	0.00040807	0.00058022	0.00185677	1.05838992
0.00053210	0.00097485	0.00727107	0.00157536	0.00372899	0.00494206	0.01258312	0.01402367	0.00940423	0.00254024
0.00014724	0.00034019	0.00031461	0.00015227	0.00051405	0.00083914	0.00024832	0.00048546	0.00067531	0.00069278
0.00005225	0.00044684	0.00035369	0.00192682	0.00008460	0.00045491	0.00001741	0.00026144	0.15301105	0.00845434
0.00044494	0.00070825	0.00307355	0.00446746	0.00076607	0.00142748	0.00046632	0.00164441	0.00967604	0.00162148
0.03278073	0.02765794	0.02971159	0.01122758	0.02298722	0.03112247	0.00253830	0.01664521	0.02085284	0.03566942
0.01165383	0.01320626	0.04540473	0.01611998	0.01013504	0.02471463	0.00273992	0.01237093	0.00851178	0.00726573
0.00048078	0.00046023	0.01383203	0.00903429	0.00193750	0.03170398	0.00040523	0.00104545	0.00126160	0.00799839
0.00210090	0.00787497	0.02560032	0.03467924	0.00354493	0.01673233	0.00984707	0.00655222	0.00541967	0.02574768
0.00163366	0.00164584	0.01187988	0.01627802	0.00377184	0.02937894	0.00027433	0.00699224	0.00523063	0.01328368
0.00370579	0.00324655	0.00782394	0.01399075	0.00260277	0.00277542	0.00015522	0.00260868	0.00243001	0.00054175
0.00027787	0.00061154	0.00576398	0.01083026	0.00059903	0.00155885	0.00060812	0.00418130	0.00342820	0.00110884
0.00054015	0.00124368	0.00158920	0.00066405	0.00142693	0.00287100	0.00113639	0.00256625	0.00246208	0.00379984
0.00043870	0.00041365	0.00471181	0.00447677	0.00034734	0.00027612	0.00004633	0.00104174	0.00272741	0.00071379
0.00304298	0.00419782	0.01889315	0.00850671	0.00703125	0.01401090	0.00478544	0.01343195	0.01106648	0.03038660
0.00114572	0.00204276	0.00845783	0.00346374	0.00236090	0.00814458	0.00161833	0.00393478	0.00441207	0.00520136
0.00980719	0.02255442	0.03151479	0.01270175	0.02310144	0.05085831	0.02201156	0.05139701	0.04460870	0.07668755
0.02402638	0.05560014	0.04252164	0.02270970	0.09318551	0.14113884	0.03595124	0.06329913	0.11051018	0.08754342
1.36268973	2.21580443	1.28442550	1.18402082	2.12993386	1.83555642	1.09921086	2.34789309	2.39535430	1.44671514

The Inverse Matrix (continued) .

11	12	13	14	15	16	17	18	19	20
0.03873036	0.00995726	0.26095761	0.00983748	0.02788609	0.00073592	0.00973343	0.00103925	0.00562236	0.00242477
0.00089374	0.00034996	0.00334178	0.00711811	0.00276591	0.00010085	0.00027246	0.00015039	0.00191163	0.00028361
0.00310705	0.00138550	0.00337487	0.00182150	0.01381881	0.00051521	0.04811796	0.03394499	0.01077809	0.00679457
0.00190358	0.00124411	0.00087189	0.00115416	0.00236955	0.10333040	0.00513739	0.01026654	0.00371851	0.00324405
0.01203871	0.00371528	0.40987299	0.00221008	0.02731570	0.00061875	0.00165761	0.00063593	0.00427008	0.00199958
0.00007546	0.00005297	0.00023309	0.00007603	0.00010405	0.00003185	0.00014458	0.00006573	0.00008732	0.00008458
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.00489460	0.00194923	0.00354700	0.04417073	0.01465446	0.00059329	0.00156870	0.00090388	0.01168239	0.00165482
0.00004224	0.00002885	0.00006849	0.00005027	0.00010203	0.00005619	0.00006995	0.00009033	0.00008510	0.00004459
0.00072570	0.00046744	0.00106648	0.00189858	0.00308854	0.00052518	0.00165201	0.00054567	0.00149178	0.00427840
1.15806475	0.26389404	0.00414233	0.00554710	0.00865586	0.00073259	0.01640400	0.00107209	0.00520126	0.00105332
0.00040283	1.00028490	0.00062762	0.00042087	0.00053580	0.00019395	0.00077544	0.00036722	0.00047043	0.00043586
0.00005709	0.00018328	1.12236939	0.00012008	0.00010562	0.00041701	0.00012946	0.00013838	0.00763983	0.00286578
0.00079349	0.00064023	0.00105526	1.01125117	0.00262617	0.00086573	0.00192874	0.00088342	0.00520477	0.01363666
0.02136284	0.03488789	0.01555454	0.05873989	1.19728014	0.00662455	0.01679216	0.00333818	0.03493298	0.02026536
0.01873014	0.01224133	0.00857886	0.01135621	0.02331495	1.01670998	0.05054887	0.10101670	0.03658791	0.03191956
0.00278157	0.00132257	0.00146517	0.00181440	0.00832769	0.00194282	1.05386858	0.01220213	0.01272780	0.00369447
0.00616168	0.01307973	0.00348709	0.00978097	0.00865597	0.00632708	0.02879128	1.40199867	0.40875672	0.26514404
0.00282830	0.00232386	0.00461120	0.00967409	0.00414575	0.00290360	0.00582120	0.00402535	1.01998562	0.01702663
0.00165475	0.00052980	0.00104889	0.00148499	0.00257937	0.00284518	0.00307655	0.00314357	0.00119665	1.03715296
0.00211963	0.00224430	0.00067181	0.00539003	0.00308382	0.00259550	0.00672299	0.00659860	0.00465534	0.01498100
0.00172821	0.00138312	0.00236252	0.00185286	0.00234137	0.00038461	0.00421463	0.00158368	0.00234702	0.00282788
0.00012653	0.00008580	0.00020596	0.00016651	0.00021342	0.00091410	0.00043997	0.00096449	0.00077326	0.00159927
0.02759252	0.01237453	0.00757155	0.05443554	0.08120961	0.00467318	0.06020358	0.03927099	0.05118372	0.03100565
0.00827740	0.00420420	0.00498775	0.00814955	0.00572828	0.00456863	0.00717511	0.00432532	0.00506480	0.00550422
0.03290982	0.02717987	0.04326229	0.03553056	0.04480913	0.00498375	0.08490081	0.03020052	0.04641287	0.05886020
0.06065816	0.03963675	0.10119936	0.06241754	0.07981708	0.03827578	0.09877152	0.05513035	0.06417404	0.04621487
1.40866114	1.43564679	2.00653583	1.34646934	1.56553518	1.20246570	1.50891898	1.71390240	1.74696229	1.57499669

The Inverse Matrix (continued) .

	21	22	23	24	25	26	27	28
1	0.00585128	0.00374735	0.03934505	0.00073221	0.00588921	0.00879852	0.00996275	4.18371820
2	0.00276069	0.00075792	0.00367405	0.00006602	0.00053136	0.00053819	0.00097500	1.41170643
3	0.00560792	0.00327298	0.00936179	0.00024051	0.02482433	0.00094954	0.00053774	1.18278335
4	0.00158049	0.00141220	0.00260098	0.00521664	0.00238022	0.00307201	0.00081601	1.16577928
5	0.00252569	0.00331962	0.01781144	0.00039976	0.00214613	0.00323010	0.00864921	2.01402503
6	0.00006734	0.00007079	0.00006397	0.00006675	0.00017010	0.00096305	0.00079082	1.00933552
7	0.	0.	0.	0.	0.	0.	0.	1.00000000
8	0.01700404	0.00453944	0.02198218	0.00039103	0.00318681	0.00317911	0.00567941	2.46594724
9	0.00013775	0.00012659	0.00003960	0.00002325	0.00012897	0.00009925	0.00065906	1.00276375
10	0.00085602	0.00254439	0.00670920	0.00040361	0.04162087	0.00235052	0.00539167	1.16498046
11	0.00751743	0.00486673	0.00590611	0.00050796	0.00401379	0.00455560	0.00930232	1.55901298
12	0.00037969	0.00039581	0.00030997	0.00033643	0.00101594	0.00437086	0.00494052	1.02067351
13	0.00087845	0.00544126	0.04422750	0.00005349	0.00056914	0.00031194	0.00023330	1.35080436
14	0.01000422	0.03898196	0.00100060	0.00104623	0.00158512	0.01776090	0.00339942	1.13696009
15	0.06795458	0.03246391	0.03408873	0.00126640	0.01204736	0.00714867	0.01139905	1.80734052
16	0.01555105	0.01389525	0.02559213	0.05132865	0.02341999	0.03022679	0.00802903	1.63117026
17	0.02605836	0.01167949	0.06155262	0.00093724	0.12853514	0.00529658	0.00202766	1.40459375
18	0.15170331	0.09581866	0.25261331	0.00420616	0.12544372	0.01115614	0.00396389	2.93518778
19	0.04750016	0.08572808	0.04012871	0.00076462	0.02329328	0.00583300	0.00195020	1.36891271
20	0.00068537	0.00935631	0.00101364	0.00192930	0.00092622	0.00182071	0.00052972	1.11085484
21	1.08867109	0.03173937	0.00205779	0.00491185	0.00854161	0.00783710	0.00212108	1.22391091
22	0.00145522	1.04520461	0.00184009	0.00245935	0.00256251	0.04673214	0.00697092	1.14655030
23	0.01106849	0.00109740	1.00199772	0.00018957	0.00066020	0.00023089	0.00090527	1.03683253
24	0.03172212	0.02063363	0.01874116	1.00163458	0.01505399	0.01999842	0.00732995	1.59998798
25	0.00414069	0.00392091	0.00632374	0.00466706	1.00344412	0.02100912	0.00788109	1.15015407
26	0.02680275	0.02937877	0.03770865	0.05214599	0.03940379	1.03623614	0.05835065	2.03431928
27	0.06069549	0.06207116	0.03633376	0.03006662	0.18938855	0.09100778	1.03229253	2.82463753
28	1.58917971	1.51246460	1.67302452	1.16599129	1.66078244	1.33471307	1.19508825	0.

Appendix A-3
Sectoral Interdependence Indices

The relative strength of each sector's linkages are calculated and presented in this appendix. The power of dispersion index (U_j) is the measure of the relative backward linkages. The sensitivity of dispersion index (U_i) measures the relative forward linkages. The six key sectors of group one and group two of table 5-2 are the ones which possess the highest linkages.

Indices of Sectoral Interdependence, Egypt, Based Upon The 1970/71 I-O Table.

Sector	Power of Dispersion Index U_j	Sensitivity of Dispersion Index U_i
1) Agriculture	0.86	2.67
2) Ginning & Pressing	1.43	0.90
3) Mining & Quarrying	0.80	0.75
4) Curd Oil	0.74	0.74
5) Food Industries	1.34	1.31
6) Beverages	1.15	0.64
7) Cigarettes	0.69	0.64
8) Spinning & Weaving	1.48	1.56
9) Ready-made Clothes	1.24	0.64
10) Wood & Furniture	0.91	0.74
11) Paper	0.86	1.01
12) Printing & Publishing	0.90	0.65
13) Leather	1.26	0.86
14) Rubber	0.84	0.72
15) Chemicals	1.32	1.25
16) Oil Products	0.75	1.04
17) Nonmetallic Industries	0.95	0.89
18) Iron & Steel	1.08	1.87
19) Metallic Industries	1.31	0.87
20) Non-electric Machinery	1.01	0.71
21) Electrical Machinery	1.02	0.78
22) Means of Transportation	0.95	0.73
23) Other Industries	1.17	0.66
24) Electricity	0.73	1.02
25) Construction	1.29	0.73
26) Transportation and Communication	0.84	1.29
27) Services	0.75	1.16

Sources: Calculated from the inverse of the domestic inter-flow matrix of 1971 I-O table. (Appendix A-2).

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