PLANNING THE STRATEGIC GROWTH AGENTS IN THE PROCESS OF DEVELOPMENT: AN ECONOMETRIC APPROACH TO THE CASE OF IRAN

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به برادرم دکتر غلامرضا باهر

و آنانکه با آرام دلشان و جهانی نا آرام در تلاش مرحله

To my brother, Dr. G.R. Baher

and to all who are not just "beings" but "becomings".

ABSTRACT

PLANNING THE STRATEGIC GROWTH AGENTS IN THE PROCESS OF DEVELOPMENT: AN ECONOMETRIC APPROACH TO THE CASE OF IRAN

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Growth theories of the last two decades, while accentuating the role of physical capital, have overlooked the significance of human capital. This omission seriously restricts the applicability and relevance of such theories to planning for development in countries which are rich in natural resources. In such countries the prominent issue is how their resources can be utilized in promoting sustained expansion in all sectors of the economy in the face of minimal labor skills.

The answer, undoubtedly, lies in qualitative improvements of that part of humanpower which is strategic to economic growth. For this reason, it is crucial that decisions are based on a reasonably articulate humanpower plan. The models that currently exist are inappropriate to deal with the problem, due both to flaws in their theoretical foundations and in their empirical validity.

This work attempts to construct a more comprehensive framework for humanpower planning, which is then applied to the case of Iran. The model postulates that the total labor

demand for each of the major economic sectors can be derived from the corresponding sectoral production functions. The skill requirements at any given level of employment could then be derived from the knowledge of coefficients of skill composition within each sectoral labor force.

Through the application of econometric techniques and the assistance of electronic computers, a general form of Cobb-Douglas production function was adopted for all the sectors as well as the whole economy. Estimation of the coefficients in these production functions, in addition to serial data for sectoral value added and labor inputs, required time-series for sectoral capital stocks. Having no such statistics, we had to develop some representative proxies. A model was built to generate sectoral capital stocks from corresponding investments. This model further required a non-linear estimation procedure to determine dummy initial capitals. The choice of capital stocks were finally made after appropriate sensitivity analyses.

After arriving at the optimum choices of sectoral production functions, under the assumptions of constancy of technology and substitutability of factor inputs, we derived our labor demand-type functions. By estimating the coefficients of these functions and, then, retrieving those coefficients for fitting the future forms of the functions, we predicted the sectoral demand for humanpower. Predictions in this regard were made on the basis of projection of sectoral value added and investments for the years 1973-82.

In so doing, we applied two alternative sets of growth rates, i.e. conceived rates in the Fifth plan (1972-77) and computed rates over the observation period (1960-72).

The predicted sectoral demand for labor was utilized to estimate their skill components through some international cross-section analyses. Two transformation matrices were built to translate the sectoral demand for humanpower into corresponding skill requirements. Application of these matrices for two alternative sets of predicted demand for humanpower provided us with four prospect patterns of skill composition during the planning span (1973-82).

Two major findings, i.e. predicted sectoral humanpower and the prospect of skill availability, show, among other things, a drastic decline in demand pattern of humanpower in the agriculture sector. Also, they indicate a shortage of almost all sorts of skills, especially at the medium-level occupations for other sectors, especially manufacturing. In any case, at the same time that accentuating the industrialization at the cost of agriculture is not a healthy development, even then, the envisaged growth of the economy is constrained by scarcity of skills. This situation threatens the feasibility of the Fifth plan and status quo, other plans in the future. Importing skills could be considered at best a short-run remedy; in the long-run strategic growth agents should be supplied domestically if the assumed pattern of growth is to be met.

Humans with lamp can sooner find
The way in dark if are not blind

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CHAPTER I

INTRODUCTION

The pursuit of higher standards of living and of economic security has led to an ever-increasing interest in economic growth and, hence, to a study of the factors which might be critical in this respect. Traditionally, economic theory dealt with three basic factors -- capital, labor and land -- under the rubric of factors of production. The land, due to its very nature, was deemed to be limited in use and was generally considered "fixed" both from quantity and quality standpoints. Therefore, the determining factors of economic development were capital stock and labor reservoir.

In the context of contemporary economics of development it is commonly accepted that the labor is an abundant factor in almost all developing economies and, hence, capital accumulation plays a vital role in the process of economic development. This hypothesis could be considered merely an approximation to reality but not the closest one. The flaw exists not only in the emphasis on the proper production factors but also in the failure to consider all factors of production.

In a modern classification of factors of production a more detailed list is given. In this list, in addition to land, labor and capital, other elements such as natural resources, entrepreneurship and technological knowledge are also included. Although this grouping is of great assistance for pedagogical purposes, it could still be improved as follows:

1. Natural resources (e.g. land and minerals)
2. Physical capital (e.g. machinery and buildings)
3. Humanpower (e.g. skilled and unskilled labor).

It is also important to distinguish between different classes of humanpower, since the type of labor which is abundant in most less-developed countries is unskilled labor, while the shortage of other kinds of humanpower are relatively more binding constraints on the growth of these economies than physical capital. In the Lepawskys' words:

> Without downgrading the importance of development capital, which is, of course, vital, the answer may be found in the decisive fact that a developing nation's capacity to absorb capital is often limited by its supply of technical skill and managerial talent. That is why a crucial kind of aid for most member nations (of the United Nations) is technical and vocational education, scientific and managerial training, and the broadening of human talent generally.[1]

Unfortunately, despite the worldwide recognition of the significant role that qualified humanpower plays in the

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[1]Albert and Rosalind Lepawsky, "Enskilling People," in Dynamics of Development, edited by Gove Hambridge (New York: 1964), p. 221.

process of economic development not enough attention has been paid to this strategic factor in the literature of development economics.[1] The general purpose of the present work is mainly to help narrow the gap, which in our view, exists between what has been done and what should be done in this respect. In so doing, the main body of the text is divided into six chapters.

After some useful introductory remarks about the subject under discussion, i.e. Strategic Growth Agents in the Process of Development, (Chapter I), the most recent literature in this respect is carefully reviewed and critically commented upon (Chapter II). Admitting that criticism is destructive unless supplemented by constructive suggestions, the rest of the work is directed towards avoiding this shortcoming. In this respect, we proceed by underlining the flaw common to previous works which lies in their method of approach to the problem of economic growth insofar as the technical consistency of approaches are accentuated rather than their approximation to reality. A good-looking regression equation between output and some inputs is desirable if it is not at the cost of assuming inputs to be homogeneous

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[1] An early outstanding work in this regard, wherein 'labor gap' is considered as an alternative gap to the so-called 'saving' and 'foreign exchange' gaps in the process of development, treats labor input as a homogeneous factor. See Hollis B. Chenery and Michael Bruno, "Development Alternatives in an Open Economy: The Case of Israel," The Economic Journal (March 1962), pp. 79-104.

knowing that they are not.[1] In order to avoid the unpleasant results of such a type of global approach, we preferred to do our research about the strategic agents contributing to the growth on a micro-analysis basis as much as possible.

The case chosen for our empirical study is Iran, a country rich in natural resources, which still suffers from backwardness due to the lack of adequate humanpower. The phenomenon of development and its planning came to Iran soon after the Second World War. Since then Iran has witnessed five medium-term development plans. These plans are the best available data source to trace the economic development in Iran, and thus are briefly reviewed in Chapter III. In so doing, implementation of the plans and the impact of their enforcement on the economic development of Iran are analyzed.

The review of past Iranian economic development in the light of its desire for growth reveals the obstacles blocking the path. Unlike most of the less-developed countries the main constraint to Iran's development is not physical capital. This is a fact we can observe simply by considering its vast area, reasonable size of population and rich minerals. The bottleneck exists, in our belief, in human capital and more specifically in qualified humanpower

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[1]These types of assumptions and operations have taken 'economics' out of 'arts' while failing to lead it toward 'sciences'. Therefore, it is not too strange if 'economics' is defined as 'what economists say'!

or as we have termed it 'strategic growth agents'. This again could be deduced from the performance of the economy even without the assistance of very sophisticated models. The symptoms of this major obstacle to economic growth of Iran have drawn attention to the search for possible solutions. Following the examination of planning models in the area of humanpower in Chapter IV, the next chapter (Chapter V) is devoted to analyse the past and present performance of the planning for strategic growth agents within the framework of the models applied to the case of Iran. In this regard we have examined not only the empirical results of the models but their theoretical foundations as well. As a result, the flaws that existed in the models became evident and hence cast doubts on their applicability. This made us search for the solution and thus further advancements in this regard.

The need for finding a way to solve the problem of qualified humanpower planning in Iran led us to make a feasible approach for planning the strategic growth agents in Iran by attempting to avoid the shortcomings of the previous works (Chapter VI). However, the inadequacy of data both from quantity and quality points of view, has resulted in an approach which is not free from flaw. Due to this shortcoming, we have called it a *ceteris paribus* approach. The policy implication of this model as well as some concluding remarks with respect to humanpower planning in Iran will be discussed in this final chapter.

CHAPTER II

UNIDENTIFIED FACTORS OF GROWTH

The importance of a high and rising stock of entrepreneurship, human skill and technological knowledge in the development of modern economies has long been recognized. Only in more recent years, however, with improvements in statistical data and analytical techniques, has it been possible to refine the measurement of these factors in economic terms. Many of the scientific works that have stressed the significance of education, knowledge, invention and innovation in the growth process have been based mainly upon econometric studies of the last two decades. The major works in this regard will be surveyed hereunder:

1. First Stage Approaches

Solow's "Technical Change"

In 1957 Robert Solow concluded that over the period of 1901-49, 12.5 per cent[1] of the rise in the U. S. gross output per man-hour was attributable to capital accumulation per man-hour while the remaining 87.5 per cent was due to

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[1] In 1958, Solow accepted a correction of 10 per cent attributable to capital accumulation per man-hour. See Review of Economics and Statistics, Vol. 40 (November 1958), p. 411.

other factors which account for changes in productivity and which Solow loosely called "technical change."[1] From a methodological point of view, he attributed the movement along the aggregate production function to capital per head and shifts of the production function itself to technical change, which he termed the "residual factor."

As a major criticism of this procedure, it may be argued that the distinction between a movement along the production function and its shift is practically impossible. This is so because our observations consist of a series of points at various times rather than a well-behaved production function.[2] Hence, in order to make such a distinction, the assumption of a well-specified production functions seems necessary.

Solow considered the Cobb-Douglas production function fairly suitable for his experimentation. Then, in testing the behaviour of technical change, he found no correlation between changes in output with percentage changes in the capital/labor ratio. Concluding that technical progress must have been neutral, he considered the following form of the

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[1]Robert M. Solow, "Technical Change and the Aggregate Production Function," Review of Economics and Statistics, Vol. 39, (August 1957).

[2]In other words, all the points are not necessarily fitted in a production function. See K. B. Griffin and J. L. Enos, Planning Development (Don Mills, Ontario: Addison-Wesley Publishing Company, 1970, p. 156.

production function:

$$Q = A\ L^{b}K^{1-b} \qquad (1)$$

where Q = real output

A = an index of technical progress.[1]

L and K = labor and capital inputs, respectively

b and (1-b) = elasticity of output with respect to labor and capital, respectively.

A function of this form is not a pure Cobb-Douglas production function but a combination of Cobb-Douglas function and the assumption of product augmenting technical progress.[2] This point was raised by Hogan[3] to which Solow's response was that "the method would automatically produce a perfect Cobb-Douglas fit if the observed shares were constant."[4]

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[1]The type of technical change which Solow accepted initially for his production function is of the "Product Augmenting" usually called "Hicks Neutrality." It affects the production function directly. For a good summary of different forms of technical change, see "Alternative Types of Technological Change and Implied Relationships," Table 5-1 of R. Millan: "Automatic Rate Adjustments and Short-Term Production Objectives for Bell Canada." Ph.D. dissertation at Economics Department of Concordia University, Montreal, September 1974 (unpublished).

For a precise description of the Cobb-Douglas production function, see W. A. Eltis, Economic Growth, Appendix II to Ch. 3. (Hutchinson University: 1966).

[3]W. P. Hogan, "Technical Progress and Production Functions," Review of Economics and Statistics (November 1958). Solow's reply is in the same reference.

[4]For an exhaustive review of Solow's model and the discussions in this respect, see C. Kennedy and A. P. Thirlwall, "Surveys in Applied Economics: Technical Progress"; The Economic Journal, Vol. 82 (March 1972), pp. 18-20.

However, disregarding the technical objections to Solow's model, it still seemed inadequate in approaching reality. The conclusions that he arrived at on the basis of his assumption were not very informative. In the words of Griffin and Enos:[1]

> They tell us nothing about the real world and neither affirm nor deny that investment is relatively unimportant or that capital accumulation and technical change are independent.

In a later article,[2] Solow emphasized that technical change was related mainly to the rate of investment in new capital goods because:

i) efficiency of capital goods depends upon its age, and

ii) investment in capital goods serves as a vehicle for introducing more efficient industrial technology.

Therefore, he adopted a "capital augmenting" type of technical progress which is called after him, "Solow's neutrality." Here, the effects of technical progress on production function is via capital:

$$Q = f(L, A \cdot K) \qquad (2)$$

Introduction of new technology into the production process only through investment in capital goods leads to results that are opposite to his earlier conclusion about the significance of the "residual factor." Hence, the

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[1] Griffin and Enos, p. 151.

[2] R. M. Solow, "Technical Progress, Capital Formation, and Economic Growth," American Economic Review (May 1962).

pioneer of "residual approach" as the causes of growth apparently tends to leave the path by simply giving weight to the physical capital and considering labor as a homogeneous factor.[1]

Kendrick's "Total Factor Productivity"

Another investigation of the sources of economic growth is associated with the work of Kendrick.[2] He provided an advancement in the "residual" approach to economic growth through taking the following steps:

1. Improvement in the measurement of changes in the quantity of labor inputs and making corrections for changes in its composition by giving a greater man-hour weight to

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[1]This assertion could also be supported by looking at Solow's measure of technical change (ibid, p. 412) as follows:

$$\frac{\dot{A}}{A} = \frac{\dot{q}}{q} - w_k \frac{\dot{k}}{k}$$

where A = index of technology
q = output per man-hour
k = capital per man-hour
w_k = capital's share of total income (=1-b)
and (.) = representing derivative with respect to time. Note that (.) in other parts of this work stands for growth rate.

[2]John W. Kendrick, Productivity Trends in the United States, National Bureau of Economic Research, Princeton University Press, 1961. An earlier summary version of Kendrick's study (and other studies) appeared in Solomon Fabricant, Basic Facts on Productivity Change, Occasional Paper 63, National Bureau of Economic Research, 1958. For a penetrating review of Kendrick's work, see Evsey D. Domar, "Total Productivity and All That," Journal of Political Economy (September 1962).

higher-paying industries.[1]

2. Refinements of real output estimates for United States, which in itself was a major contribution to analysis of economic growth.

3. Development of a measure of capital and labor inputs combined through weighing each input by its constant base period price.

4. Measurement of productivity in terms of output per unit of combined factor inputs.[2]

Kendrick's method was to compare the growth in real output with combined growth of labor and capital inputs. His experiment covered the period 1889-1957 for the United States and found 1.9 per cent difference between those two rates is what he attributed to the increase in productivity of factor inputs or what he called the increase in "total factor productivity."[3]

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[1]As we will see later on, the difference between Kendrick's approach and Denison's approach in measuring the productivity is that Kendrick's approach is based on the interindustry average wage differentials, while Denison's method is to measure differences in productivity of labor force associated with differences in education.

[2]The conventional measure for productivity is output per unit of labor input.

[3]Kendrick, Table 6, p. 79. Fabricant shows from data based on Kendrick's study, that in the period 1929-57, real output in the United States rose at an annual average rate of 3.1 per cent while weighted labor and capital inputs combined grew at the annual rate of 1 per cent, yielding a residual rate of 2.1 per cent per year.

Kendrick's "total factor productivity" measurement was a significant advance in the residual approach or what Bowen has called a "mandate to explore in detail the economic effects of activities often neglected."[1] But, despite Kendrick's effort in exploring the residual factors affecting growth, his method excluded other unspecified inputs such as variables which Fabricant deemed to be included in "society's intangible capital":

> In an important sense, society's intangible capital includes all the improvements in basic science, technology, business administration and education and training, that aid in production -- whether these result from deliberate individual or collective investments for economic gain or are incidental by-products of efforts to reach other goals. If intangible capital were so defined, it would probably follow that much (not all) of the increase in product would reflect increase in resources. But so wise a definition of intangible capital would get us no closer to determining the causes of increase in product.[2]

Therefore, exclusion of "other factors" from the measurement of residual factors resulted in Kendrick's measure of factor productivity to be overstated.

Denison's "Advance of Knowledge"

The most well-known effort to date in measuring the unidentified factors affecting economic growth is associated

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[1]William G. Bowen, "Assessing the Economic Contribution of Education: An Appraisal of Alternative Approaches" in Economic Aspects of Higher Education (Paris: OECD, 1964), p. 184.

[2]Fabricant, p. 22.

with the name of Edward F. Denison.[1] His work has evoked a great deal of controversy in the economic literature since it first appeared.[2] Therefore, Denison's model seems to deserve some elaboration. But before doing so, it is interesting to have some idea of the results that his approach yielded. He tried to identify and measure the changes in the labor and capital inputs associated with the total changes in the national income of the United States over the period 1929-57. The result that he found could be summarized roughly as follows:

i) 2/3 of the growth rate was attributable to the increase in the quantity of the total identifiable inputs, including changes in labor quality.

ii) 1/3 of the growth rate (residual) was attributed to the unspecified inputs.

Denison provided a further approach to specify this

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[1]Edward F. Denison, The Sources of Economic Growth in the United States and the Alternatives Before Us, Supplementary paper No. 13, Committee for Economic Development, January 1962.

[2]For example, see Moses Abramovitz, "Economic Growth in the United States, A Review Article," American Economic Review, September 1962, for an excellent commentary on Denison's work. Essays by Friedrich Edding, Edmond Malinvaud, Erik Lundberg and Jan Sandee, representing mainly a European point of view, as well as a lucid summary by Denison of his work and his Reply are contained in The Residual Factor and Economic Growth (Paris: OECD, 1964), Part I. Some further discussion by Denison concerning his study and comments by Robert Solow, Otto Eckstein and Seymour Harris appear in Seymour Harris and Alan Levensohn, Eds., Education and Public Policy (Berkeley: McCutchan Publishing Co., 1965), Chapter 16.

first-stage residual and arrived at a final residual which represented approximately 1/5 of the average annual growth rate over the period considered. He attributed this residual to what he called "advance of knowledge."

Nelson's Model

In order to have a better understanding of Denison's findings it seems necessary to have an idea about his method. Although he has not explicitly stated his model in the form of an aggregate production function, such a framework has been attributed to it in the literature. Nelson's work in this respect is of great significance.[1] He has provided a formulation of Denison's model to show not only a more apparent contribution of education to economic growth but also how to incorporate the labor quality change in his framework as well as in other aggregate production functions.

The formulation of Denison's model by Nelson could be shown as follows:

$$Q_t = A^*_t (L_t q_t)^b K_t^{1-b} \qquad (3)$$

or

$$\frac{\Delta Q_t}{Q_t} = \frac{\Delta A^*_t}{A^*_t} + b\frac{\Delta(L_t q_t)}{L_t q_t} + (1-b)\frac{\Delta K_t}{K_t} \qquad (4)$$

[1]Richard R. Nelson, "Aggregate Production Functions and Medium-Range Growth Projections," American Economic Review (September 1964), pp. 575-606.

where

$\frac{\Delta A_t^*}{A_t^*}$ = the part of the growth of output not directly embodied either in capital or labor (e.g. due to improvements in the allocation of resources and better management practices)

$\frac{\Delta K_t}{K_t}$ = rate of growth of capital (without any specific adjustment for quality change)

q_t = labor quality index which stands for an improvement in the average quality of labor

A_t^* = technical change index

Note that the term A_t^* in this model is more limited in size than A_t in Solow's first model. This is so because in Denison's model the labor quality improvement change is taken care of in the term $\frac{\Delta(L_t q_t)}{L_t q_t}$. Therefore, $\frac{\Delta A^*}{A^*}$ could be interpreted as the rate of growth of what Denison has called "advance of knowledge" and some organizational improvement in efficiency including:

- positive adjustments for reduced waste of labor in agriculture
- negative adjustments for restrictions against optimum use of resources
- change in lag in application of knowledge
- economies of scale
- shift from agriculture to industry

Adjustment for quality improvement of labor force plays an outstanding role in Denison's model. To have better understanding of it, the term $\frac{\Delta(L_t q_t)}{L_t q_t}$ of the second version of the above production function could be expanded as follows: since q_t, in addition to improvement in the average quality of labor expresses an improvement in the productive efficiency of new workers, it becomes also necessary to take account of changes in the age composition of labor. Therefore $\frac{\Delta(L_t q_t)}{L_t q_t}$ could be written as:

$$\frac{\Delta(L_t q_t)}{L_t q_t} = \frac{\Delta L_t}{L} + \lambda_L - \lambda_L \Delta \bar{E} \qquad (5)$$

where:

$\frac{\Delta L_t}{L}$ = rate of changes of labor input in physical units

L = yearly rate of improvement in the average efficiency of labor force

$\Delta \bar{E}$ = change in the average age of the labor force

$\lambda_L \Delta \bar{E}$ = the effect of changes in the average age of labor force

Therefore, the adjusted growth function takes the following form:

$$\frac{\Delta Q_t}{Q_t} = \frac{\Delta A_t^*}{A_t^*} + b\left(\frac{\Delta L_t}{L} + \lambda_L - \lambda_L \Delta \bar{E}\right) + (1-b)\frac{\Delta K_t}{K_t} \qquad (6)$$

Assuming that 60 per cent of differences in earnings is due to differences in the amount of schooling, Denison used income differentials through education as weights to obtain an index of improvement in the quality of labor via schooling. On the basis of this procedure, Denison found that over the period 1929-57 the growth of education raised the quality of the U.S. labor force equivalent to an increase of 0.93 per cent in its yearly quantity. From here on, by considering the elasticity of output with respect to labor of 0.73, he concluded that the contribution of education to the annual growth rate of 2.93 was 0.67 percentage points or 23 per cent and that its contribution to the growth rate of real national income per person employed (1.60) was 42 per cent.[1]

In order to come to some conclusion on the works of Solow and Denison it seems appropriate to categorize the discussions made on their approaches into two groups: criticisms and comments. The former views could be

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[1]Denison also calculated the effects of education over the period 1950-62 for the United States (U.S.), North West Europe (N.W.E.) and England (U.K.). His findings could be summarized in the following table:

Countries	Rate of Growth of the quality of labor due to education (% per annum)	Contribution of the growth of education to growth of national income (%)
U.S.	0.7	15
N.W.E.	0.35	5
U.K.	0.37	12

*Source: E. F. Denison, Why Growth Rates Differ: Post-War Experience in Nine Western Countries, Brooklings Institution (Washington, 1967). For an excellent review of Denison's later approach, read A. P. Thirlwall, Growth and Development, Appendix 2.1, pp. 61-71 (1972).

represented by the argument made by Griffin and Enos as:[1]

> It is entirely illegitimate to postulate that the residual which Solow and others imagined they found in advanced countries is due to "improvements in knowledge." The error is compounded when this conclusion is transferred to educational planning in the underdeveloped countries.[2] ... education may have an important role in accelerating development, but this proposition cannot be demonstrated by referring to studies of the aggregate production function.

Obviously, these criticisms are directed mainly towards the application of aggregate production functions in specifying the causes of growth. The solutions usually suggested in this respect are of the micro-analytic type; in other words, measuring the significance of the contribution of any possible factor in the economic growth on an individual basis rather than as an argument in an aggregate production function.[3]

The comments which are mostly constructive are made mainly by the supporters of production function approach to the study of the causes of growth. For instance, Thirlwall in his concluding remarks on Denison's works argues that:

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[1]K. B. Griffin and J. L. Enos, Planning Development, p. 156.

[2]See T. Balogh and P. P. Streeten, "The Coefficient of Ignorance," Bulletin of the Oxford University Institute of Economics and Statistics, Vol. 25, No. 2, 1963.

[3]This line of thought will be elaborated more in the following parts.

> There is no doubt that Denison has performed an extremely useful task in quantifying the contribution of increases in physical factor inputs to growth in so many countries, and that his estimates can be accepted with some degree of confidence. His attempt to quantify the sources of increases in output per unit of input, however, falls short of complete success, and some of his conclusions must be considered of doubtful worth. As much as one admires his attention to detail, the present state of our knowledge does not permit some of the sweeping assumptions that Denison is forced to rely on. The residual factor in economic growth remains the 'Coefficient of our ignorance'.[1]

2. The Second Stage Approaches

Considering the efforts made by Solow, Kendrick, Denison, Nelson ... as the first stage approaches in exploring and measuring unidentified growth contributing factors, it seems appropriate to name the further advances made in this regard as "The Second Stage Approaches." In order to survey these developments the major works are reviewed in the following section.

Labor Quality Adjustment

The significance of labor inputs with different qualities was recognized a long time ago, yet it was never explicitly introduced into the production functions until recently. Denison, for instance, is one of the first to introduce the labor force into the production function as a non-homogenous factor input. In order to construct an index of the growth of labor force over the period 1909-58

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[1]Thirlwall, p. 70.

for the U.S. economy, he was in need of a weighting scheme to arrive at a total labor index. For this purpose, an assumption about the elasticity of substitution between different types of labor with different qualifications was needed. Denison assumed this elasticity of substitution to be near infinity, and then weighed different labor inputs by their earnings. Through the use of such a linear combination of labor force and relative wages he was able to analyze the sources of growth in different countries.[1]

Therefore, the cornerstone of Denison's method was the assumption of infinite elasticity of substitution between members of a non-homogenous labor force. This was a crude approximation of a true labor index because, if the elasticity is other than infinite as is likely, then a change in the quality composition of the labor force necessarily will affect relative wages and hence invalidate Denison's weighing scheme.

On the other hand, a different view is taken in the so-called manpower-requirement models.[2] The elasticity of substitution in these models is assumed to be zero, an

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[1]See E. F. Denison, Why Growth Rates Differ.

[2]See J. Tinbergen and H. Bos, "A Planning Model for the Educational Requirements of Economic Development," in The Residual Factor and Economic Growth (Paris: OECD, 1964). Also, G. H. Baher, "A Planning Model for the Educational Requirements of Economic Development: The Case of Iran," Journal of Economic Research (Winter & Spring, 10 (29-30)), pp. 170-205.

assumption that has also been questioned. For instance, Freeman argues that:

> The absence of substitution between various types of labor skills is often cited as a fatal flaw, especially since econometric evidence suggests that elasticities are quite high.[1]

These deficiencies prompted Bowles[2] to introduce a weighting system that would incorporate exact values of the elasticity of substitution between different labor inputs. The aggregate production function that he considered is of the following form:

$$Q = F(K, L^*) \quad (7)$$

where L^* is the total supply of quality-adjusted labor in the following function:

$$L^* = h(L_1, \ldots L_n) \quad (8)$$

in which $L_1, \ldots L_n$ are different labor inputs classified according to their level of education. Therefore the production function (II-1) could be written as:

$$Q = F \left[K, h(L_1, \ldots L_n) \right] \quad (9)$$

Assuming that "the level of non-labor inputs has no bearing on the relative marginal productivities of the

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[1] R. B. Freeman, "Manpower Requirements Analysis and the Skill Composition of the U.S. Work Force," Harvard Institute of Economic Research, Discussion Paper No. 355, April, 1974.

[2] Samuel Bowles, "Aggregation of Labor Inputs in the Economics of Growth and Planning: Experiments with a Two-Level C.E.S. Functions," Journal of Political Economy (Jan. - Feb. 1970), 78(1), pp. 68-81.

different types of labor inputs,"[1] he went on to estimate the elasticity of substitution (e_{ij}) among labor classes with different levels of schooling (L_1 and L_j) as:

$$e_{ij} \equiv - \frac{d(L_i/L_j) \; / (L_i/L_j)}{d(W_i/W_j) \; / (W_i/W_j)} \qquad (10)$$

or

$$e_{ij} \equiv - \frac{d \;\; \log \;\; (L_i/L_j)}{d \;\; \log \;\; (W_i/W_j)} \qquad (11)$$

where W_i and W_j are wage rates earned by L_i and L_j respectively.[2] Bowles distinguished three levels of schooling for twelve different countries (more developed and less developed) as:

L_1 = first level labor with zero to seven years of schooling

L_2 = second level labor with eight to eleven years of schooling

L_3 = third level labor with twelve or more years of schooling.

The general form of equation used for estimating the elasticity of substitution could be shown as:

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[1]S. Bowles, p. 70.

[2]In a footnote, Bowles reminded that: "Throughout, we make the assumption that relative labor earnings measure relative marginal products. I will not deal here with the usual questions concerning the validity of this assumption, or the measurement of the economic effects of schooling by differences in earnings among workers classified by years of schooling." For a survey of some of these issues, see chapter 2 in Bowles, Planning Educational Systems for Economic Growth.

$$\log \left(\frac{W_i}{W_j}\right)_k = a + b_{ij} \log \left(\frac{L_i}{L_j}\right)_k + u_k \qquad K=1,\dots 12 \text{ (different countries)} \qquad (12)$$

$$\text{Hence: } e_{ij} = \frac{d \log (L_i/L_j)}{d \log (W_i/W_j)} = \frac{1}{b_{ij}} \qquad (13)$$

On the basis of his findings, Bowles thought of the possibility of aggregating the labor inputs with the second and third levels of schooling (L_2 and L_3). Accordingly, he proposed a simple method of aggregation as follows:

$$L' = L_2 + L_3 (W_3/W_2) \qquad (14)$$

where L' = synthetic factor (aggregation of the two more-educated categories)

W_3/W_2 = ratio of wage rates of L_3 to L_2 (from the cross-sectional earning data)

This aggregation is made under the following assumptions about the marginal rate of substitution between L_2 and L_3 being:

(i) independent of the relative quantities of these two factors, and

(ii) independent of the quantity of L_1, or that:[1]

$$d(W_2/W_3)/d\,(L_1/\bar{L}) = 0 \qquad (15)$$

where $\bar{L}$ = the total labor force

[1]See W. W. Leontief, "A Note on the Interrelation of Subsets of Independent Variables of a Continuous Function with Continuous First Derivaties," Bulletin of American Mathematic Society 53 (1947), pp. 43-50(a) "Introduction to a Theory of the Internal Structure of Functional Relationships," Econometrica, 15 (October 1947), pp. 361-73(b).

Defining the earnings of the aggregated factor (W')

as:

$$W' = (L_2W_2 + L_3W_3)/L' \tag{16}$$

he found the following estimating equation:

$$\log \frac{W'}{W_1} = 1.3403 - \underset{(t=-5.105)}{.1242} \log \frac{L'}{L_1} \quad R^2 = .7274 \tag{17}$$

which implies the elasticity of substitution between more educated (L') and less educated (L_1) labor categories as:

$$e_{i'1} = - \frac{1}{\hat{b}} = 8$$

This elasticity implies that, when considered as part of a growth process, an 8 per cent change in the ratio of L' to L_1 is associated with a 1 per cent change in their relative earnings.

Even though the elasticities of substitution which Bowles estimated were based on some simplifying assumptions,[1] he constructed an aggregate function for the supply of labor services on the basis of those estimates.[2] In addition, in order to measure the significance of this aggregation, he compared his findings with the results of other types of aggregations based on the two extreme alternative assumptions

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[1]S. Bowles, p. 74.

[2]Bowles built his aggregation function on the basis of Sato's (1967) two-level C.E.S. function where the weighting scheme incorporates exact values of the elasticity of substitution between pairs of educated labor. This procedure is elaborated in detail in Appendix A.

about the elasticity of substitution, namely unity and infinity. Table II.1 shows Bowles' labor indices estimated for 12 countries in which the values are expressed as a fraction of the values for the United States.

TABLE II-1

AMOUNT OF QUALITY ADJUSTED LABOR BY COUNTRY ACCORDING TO VARIOUS LABOR AGGREGATION INDICES, EXPRESSED AS A FRACTION OF THE U.S. AMOUNT

	AGGREGATION INDICES			
	L (1)	L^* (2)	L^∞ (3)	L^1 (4)
United States	1.00000	1.0000	1.0000	1.0000
Belgium	.05215	.0447	.0417	.0534
Canada	.1031	.0867	.0848	.1[illegible]82
Chile	.0400	.0233	.0231	.0299
United Kingdom	.3504	.2816	.2783	.2490
France	.2608	.2081	.2024	.2706
Greece	.0530	.0397	.0383	.0575
India	2.7822	1.4118	1.4524	1.265
Mexico	.1931	.0978	.1007	.0869
Netherlands	.0697	.0556	.0544	.0667
Colombia	.0884	.0446	.0462	.0345
Israel	.0104	.0096	.0095	.0113

Source: S. Bowles, "Aggregation of Labor Inputs in the Economics of Growth and Planning," <u>Journal of Political Economy</u>, 78(1), 1970, p. 79.

Note that L is the total number of total males economically active and L^1, L^∞ and L^* aggregated indices based on the consideration of elasticities of substitution to be equal to one, infinity and exact estimated values, respectively. The estimation procedure for all of these indices will be explained later on.

Although the above approach (mainly by Bowles) could be considered as a break-through in both areas of humanpower planning and economics of growth, they were neither very accurate nor comprehensive. The following are the major shortcomings with this approach:

1. It disregards the role which is played by capital and its changes.
2. It used limited categories of qualified manpower and ignored uneducated labor force.
3. Treated both developed and underdeveloped countries alike by applying the same estimating equation to both of them.
4. Assumed the observed earnings to be equal to the marginal products.
5. Made no integration between supply and demand in measuring the elasticities of substitution.
6. Specification error in the measurement of elasticities.

In what follows, the main efforts which have been made so far to remove these deficiencies will be reviewed.

Psacharopoulos and Hinchliffe[1] have responded to the first three shortcomings by:

1. Adding the uneducated category of labor to the other three types which have already been distinguished by Bowles.
2. Increasing the number of countries to eighteen and treating developed and less developed countries separately.
3. Including the capital factor in the elasticity estimating equation as follows:

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[1]G. Psacharopoulos and K. Hinchliffe, "Further Evidence on the Elasticity of Substitution among Different Types of Educated Labor," Journal of Political Economy, 80(4), 1972.

$$\log \left(\frac{W_i}{W_j}\right)_c = a + b \log \left(\frac{L_i}{L_j}\right)_c + \gamma \log \left(\frac{K}{L}\right)_c \quad (18)$$

where W_i, W_j, L_i and L_j stand for the same elements as before

$(K/L)_c$ = capital-labor ratio in country c

Notice that: 1) the equation (18) is an inverted labor-demand equation in which K/L plays the role of a shift variable; ii) elasticity of substitution between each pair of labor type $e_{ij} = -\frac{1}{b}$ and iii) elasticity of substitution between capital and labor $\sigma = -\frac{1}{\gamma}$.

Assuming the market wage rates to be equal to the marginal products of labor, the following experiments have been made:

Experiment A: Excluding the capital and estimating equation (18) for all countries when four groups of labor inputs are recognized, the results of this experiment indicated that:

i) the elasticity of substitution is greater for lower skill levels;

ii) statistical estimation of the relationship between higher skill level categories is more significant.

Experiment B: Considering developed and less-developed countries separately and estimating equation (18) only for skill levels of types 2 and 3, the results indicated the very high elasticity of substitution between the labor force with the second and third level of schooling in more-developed countries in comparison with less developed countries. This implies that the possibility of substitution between the top labor force in the former countries is much greater than that of the latter. In other words, relative earnings of the labor categories is a better indication of their relative supply in less developed economies when compared with more developed ones.

Experiment C: Including the capital-labor ratio in equation (18) and measuring the effects of treating physical capital as constant both in more developed and less developed countries.

The results of this experiment when compared with their previous associated regressions indicated the following effects of capital:

1. Drastic decrease in elasticity of substitution (from 1000 to 20) in more developed countries. The lower elasticity implies the lesser possibility of substitution and hence that relative earnings is a better explanation for relative supplies.

2. Moderate increase in elasticity of substitution (from 2.1 to 2.5) in less developed countries. This means that changes in physical capital do not have a significant effect on the composition of labor force at higher level of quality.

3. Positive sign corresponding to the capital-labor ratio for more developed countries, which implies that the greater the capital labor ratio the wider is the gap between the amount earned by the labor force with the third and second level of education. This indicates a high degree of complementarity between physical capital and highly qualified human-

power in more-developed countries.[1]

Simultaneity of Demand and Supply

The works on the elasticity of substitution between different types of labor which we have surveyed so far viewed the labor market from its demand side. This helps in the specification of a more refined production function to take into account workers' choice between a range of occupations depending on their educational qualifications. Such an approach, though necessary, is not sufficient in providing us with all the ingredients needed to look for appropriate policies.

If the distribution of income depends on the qualification of the labor force, then the possibility of substitution has a direct influence on the demand structure of the labor market through wage rates differentials. Thus, the estimation of the demand function and its corresponding elasticities of substitution seems inevitable. Tinbergen in this regard states that:

> Apart from the use for further scientific analysis the subject of substitution between types of labour has an immediate practical aspect when it comes to finding

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[1]See Z. Griliches, "Capital-Skill Complementarity," Rev. Econ. and Statis. 2, No. 4 (November 1969), pp. 465-8, also: "Notes on the Role of Education in Production Functions and Growth Accounting," in Education, Income and Human Capital, W. Lee Hansen (ed.), New York: National Bureau for Economic Research, 1970.

adaptations to changes in trade policies as now required -- and rightly so -- by the developing countries.[1]

The perception of this need has led to some recent attempts to measure the possibilities of substitution between different labor forces on the demand side which is mainly influenced by the organizers of production rather than the willingness of individual workers based on their preference functions.[2] In order to have an idea of this approach, a brief review of Tinbergen's model seems invaluable.

Being interested in the reduction of income inequality in the U.S. economy, Tinbergen believes that substitution of the third level humanpower (with more than 11 years of schooling) by all others is more relevant than any other substitution. On the basis of this, he has tried to derive the long-run elasticities of substitution between those two categories from supply and demand equations separately as follows:

Supply:

$$\frac{L_1 + L_2}{L_3} = a_1 \frac{W_1 + W_2}{W_3} + a_2 L_2 + a_3 \qquad (19)$$

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[1] J. Tinbergen, "Substitution of Graduates by Other Labour," Kyklos, 27(1-2), 1973, p. 217.

[2] See for example the works by R. B. Freeman, The Market for College-Trained Manpower (Cambridge, Mass., 1971); also J. Tinbergen, "Actual vs. Optimal Income Distribution in a Three-Level Education Model," to be published in a volume in honour of Professor Tagliacarne, edited by Professor DeMeo; and J. Tinbergen, "Substitution Between Types of Labor in Production," to be published in a volume in honour of Professor Del Vecchio.

Demand:

$$\frac{L_1 + L_2}{L_3} = b_1 \frac{W_1 + W_2}{W_3} + b_2 u + b_3 \qquad (20)$$

Where: L_1 and W_1 stand for the same elements as before

u = a measure of the services sector[1]

a_1 and b_1 = regression coefficients

Fitting these models with the Bowles'[2] cross-nation data, Tinbergen found alternative results. According to which the supply elasticity was not significantly different from zero; hence, it indicated not too strong a motivation for investment in advanced levels of education. On the other hand, the demand elasticity which was not significantly different from unity, confirmed the validity of using a generalized Cobb-Douglas production function in the measurement of humanpower requirements.

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[1]"u stands for the per mille of the active population in utilities, health services, transportation and communication (ISIC 5 and 7); admittedly an incomplete measure or the services sector, since education and government are not included." Tinbergen, p. 221.

[2]S. Bowles, Planning Educational Systems for Economic Growth, 1969.

SUMMARY II

In summing up our review of the approaches made towards specification and measurement of invisible factors contributing to economic growth, it seems reasonable to state that the scientific, though not necessarily the systematic, works in this respect have coincided mainly with the econometric studies of the last two decades. These studies initially concentrated on the production approach to the causes of growth; we have called them 'The first stage approaches'.

The general responses to the first stage approaches are classified as comments and criticisms. Comments imply the advancement made in the search for unidentified factors of growth along the line of production approach. These studies are constructive in the sense that they have tried to sustain the production approach through improving its application. These improvements are called "the second stage approaches" and we will consider the contribution of these approaches in the formulation of our production function later on in this work.

Another category of responses to the first stage approaches was what we have called criticisms. Economists who did not like the production approach to the causes of growth have rejected its appropriateness to identify and measure the invisible factors contributing to economic growth by arguing that this could be done more accurately on a micro basis. In so doing, the probable factors should be specified and their contribution to growth should be measured individually.

This kind of disaggregated approach, though time-consuming, seems more comprehensive as well as informative. This is the type of approach that will be considered in the forthcoming theoretical analyses and empirical computations of the present research work.

CHAPTER III

THE ECONOMIC EVOLUTION OF IRAN

Iran, a land of 1,648,195 square kilometers and about 34 million inhabitants with almost $1,500 per capita income is best known, nowadays, as the second largest oil exporting country in the world. The economic system of Iran since its known early history (more than 2,500 years ago) up to the modern era had been based on agriculture. Agrarian activities of Iran, though always very primitive, had been successful enough not only to satisfy domestic needs to the agricultural products, but also to export them to a large extent.

The first major change in the dominantly agrarian structure of the economy came into effect as a result of exploitation of natural resources other than land and water, namely, minerals and mainly oil. Oil, though not very significant in early times of its extraction, has played such a critical role in the modern era of the economy of Iran that has termed it to a 'dualistic economy'. Leaving aside the controversial arguments about the role of oil in the economic evolution of Iran, the country presently has an exceptionally high rate of economic growth (based mainly on oil) with a rather primitive agriculture (incapable of providing enough food for an increasing number of inhabitants) is leading towards industrialization.

Presently, Iran is experiencing a transitory period in its economic life. Hence, any prediction about the future of Iran should be made with caution. Nonetheless, thanks to the richness of its natural resources, it could be admitted that Iran is one of the rare countries which has the potentiality of reaching a good level of economic development. Disregard of such an idealistic goal, which is rather hypothetical in the context of our contemporary economics, the bulk of natural resources is not enough to attain a good level of continued growth in the absence of sufficient number of qualified humanpower. This is a fact that could be confirmed by examining the development pattern of Iran in its era of modernization.

Iran, which is considered nowadays as one of the leading countries among the economically backward societies, started its new era of "development" right after the Second World War. This movement coincides with the initiation of planning in Iran. Therefore, it seems appropriate to survey the economic development of Iran in the context of its development plans. Disregarding the questions about when, where, why and who began the idea of planning in Iran, which involves a great deal of controversy,[1] in this chapter we

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[1]See, for example, George Baldwin, Planning and Development in Iran, John Hopkins Press (1967), p. 196. Also, Julian Bharier, Economic Development in Iran 1900-1970, Oxford University Press, (London: 1971).

concentrate mainly on the "how" aspect of the development plans where economic performance during each plan is briefly discussed.

1. The First-Development Plan (September 1948-September 1955)

The First Plan in Iran was initiated before the end of the Second World War, apparently for the sake of Iran's reconstruction and development. It was a general plan for government expenditure for a total of 62 billion Iranian rials.[1] This was later revised downward to 21 billion rials due to the shortage of financial sources and lack of qualified humanpower.[2]

The First Plan consisted of a collection of public sector projects which were rather inadequately interrelated and devoid of unity and comprehensiveness. Inevitably, a large number of difficulties occurred in its implementation. There was a shortage of reliable statistics and data; those in charge were inadequately informed about the state of the country, while the specialists were also inadequately informed and too few in number to prepare and implement the Plan properly.

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[1]Rial (Rl) is Iran's unit of money, almost equivalent to 1/65 Canadian Dollar (December 1975). However, due to the lack of access to its par value in the past, it was not possible to convert it into dollars.

[2]See plan organization, The Collection of Development Plans Acts (in Persian), Part I, pp. 2-6, n.d.

The Economic Performance of Iran During the First Plan

Despite all the difficulties, however, the implementation of the First Plan did start and the foundations of Plan Organization as the country's planning agency were laid (1949).[1] The attention was paid to the industries which had been established already and which, because of over-exploitation and the lack of proper maintenance, were in a pitiful state. The investments aimed at resuscitating these industries and creating new ones, and the projects which were to be carried out in agricultural development and road construction were deemed to be the first steps towards the development of agriculture, the industrialization of the country and mobilisation of humanpower.

But, the young Plan Organization had just begun to implement the First Plan when, following the nationalization of oil industry in 1951, the flow of oil revenue was interrupted due to the economic embargo on Iran by the West. This, in addition to the shortage of finance from other

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[1] "Established by legislative authority, the Plan Organization was substantially independent of regular government ministries and had financial allocations apart from the regular budget. Despite its name, it bore no resemblance to the usual central planning agency. It was intended to be an independent action agency able to execute capital investment projects without the delays, inadequacies, and political orientation of the normal government ministries." J. P. Gittinger, Planning for Agricultural Development: The Iranian Experience, Planning Experience Series No. 2, Center for Development Planning, National Planning Association, 1965, p. 54.

sources were among the obstacles to success.[1]

2. The Second Development Plan (September 1955-September 1962)

With the resumption of oil payments in 1954, it was decided that a new development plan should be worked out to fit the altered circumstances. Thus, Plan-Organization embarked on the second seven-year development plan in 1955. The second plan, like the first, was primarily a grouping of government capital investment projects, mainly executed by foreign contractors, the Plan Organization's own staff of specialists and foreign consultants.

The Second Plan began in more favourable circumstances and in a period of greater prosperity. The reactivation of Iran's oil industry provided a solid financial basis for the Plan, and there were no major obstacles to prevent the execution of large-scale projects. The Second Plan's mission was to found the essential infrastructure for the economic transformation that was to come. The construction and development of roads, dams and ports, the introduction of vocational and technical education and the mobilization of some part of humanpower.

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[1]For more information in these respects, see N. S. Fatemi, Oil Diplomacy, Powder Keg in Iran, Whittier Books, Inc., New York, 1954; also, M. Tanzer, The Political Economy of the International Oil and the Underdeveloped Countries, Beacon Press, Boston, 1969; and M. Amir Fardi, A Macroeconomic Analysis of a Petroleum Export Economy: Iran as a Case Study, Ph.D. dissertation in Economics at University of Illinois (unpublished), Urbana, 1972.

The Economic Performance of Iran During the Second Plan

The implementation of the Second Plan was successful in some respects but a failure in others. The performance of the economy during the Second Plan made it possible to achieve an average annual growth rate of 4.3 per cent in current prices (GNP rose from 229 billion rials in 1955 to 301.0 billion rials in 1962).[1] This rate is insignificant when we regard the low level of initial GNP.

3. The Third Development Plan (September 1962-March 1968)

Problems of fiscal control and organizational efficiency became increasingly critical during the Second Plan. This led to the establishment of an Economic Bureau, later, the Division of Economic Affairs in 1958. A staff of competent Iranian economists -- many newly-returned from graduate study abroad -- was recruited for the Division. In addition, a team of economic advisors drawn from Europe and North America was attached to the Division. This group remained on the scene until September 1962.

At first, the main responsibility of the Division was to improve organization and tighten budget controls within the Plan Organization. In mid-1959 the Division was assigned formal responsibility for preparing the Third Plan to begin when the Second Plan ended in September 1962. The Third Plan was actually to continue until March 1968, a period of five

[1] Plan Organization.

and a half years. The extra six months allows the planning period to be phased with the Iranian calendar.

In its directive, the Cabinet notified the Division that the scope of the Third Plan was to be much broader than those preceding. Planning was to take account of Iran's entire resources structure. Policies which could harness both public and private activities to achieve national development goals were to be included. However, detailed estimates were not made for all economic activities. It stipulated only that consideration be given to creating conditions within which private activities could move most rapidly to promote economic and social development. The role of the Plan Organization in direct execution of government programs was to be reduced and increasing responsibility assigned to normal government agencies.[1]

The Economic Performance of Iran During the Third Plan

National Product and its Growth: Iran's economic development during the Third Plan was characterized by a high rate of growth and relative price stability. During the six years ended by March 20, 1969, the gross national product at constant prices increased at an annual compound rate of

[1]For more information, see B. Abadian, "Allocation of Resources in the Third Plan and Investment Criteria," in Conference on Development Planning, Central Treaty Organization (CENTO), Tehran, May 1962, pp. 55-60.

about 9 per cent. Prices, as measured by the GNP price deflator, increased by slightly over 1 per cent per year during the same period. With the population growing at an annual rate of close to 2.8 per cent, real per capita income increased on the average by over 6 per cent during the six years. Per capita GNP in 1968 amounted to about Rls. 23,300 ($308).

As shown in Table III-1, real GNP increased at an annual compound rate of about 8.5 per cent during the five years of the Third Plan ended March 20, 1968;[1] thus the Third Plan target of 6 per cent was exceeded. Consumption expenditures in constant prices increased at the lower annual compound rate of 7.6 per cent during the same period. Of the total consumption expenditures, public sector expenditures increased sharply (annual compound rate of growth of 15.4 per cent) while private consumption expenditures grew at a much lower rate (6.3 per cent). As a result, the proportion of public sector expenditures in total consumption expenditures rose from 12.1 per cent in 1962 to 17.2 per cent in 1967/68. The high rate of growth in public sector consumption expenditures was reflected in most categories of government expenditures with defense spending showing higher than average

[1] In order to simplify the discussion of developments during the Third Plan, the five-year period from March 1963 to March 1968 will be used rather than the actual five and one-half year period from September 1962 to March 1968.

increases. During this period, private consumption expenditures represented a declining share of GNP, from about 71 per cent of GNP in 1963 to 65 per cent of GNP in 1967.

Table III-1

Gross National Product of Iran During the Third Plan
(in billion rials at constant prices of 1959)

	1962	1963	1964	1965	1966	1967
1. Consumption expenditures	262.5	274.0	297.7	325.6	346.4	379.0
Private sector	(230.7)	(240.2)	(256.4)	(272.8)	(287.6)	(313.8)
Public sector	(31.8)	(33.8)	(41.3)	(52.8)	(58.8)	(65.2)
2. Gross domestic fixed capital formation	49.3	53.2	61.9	79.3	86.5	108.3
Private sector	(33.6)	(35.4)	(42.6)	(46.1)	(51.7)	(56.1)
Public sector	(15.7)	(17.8)	(19.3)	(33.2)	(34.8)	(52.2)
3. Gross domestic expenditures (1+2)	311.8	327.2	359.6	404.9	432.9	487.3
4. Net exports of goods and services[1]	10.3	12.0	5.0	3.7	0.3	-2.6
5. GNP = GNE (3+4)	322.1	339.2	364.6	408.6	433.2	484.7
6. Less: Capital consumption allowance	22.5	23.7	25.5	28.6	30.3	34.0
Indirect taxes	19.0	20.8	20.7	26.1	30.1	35.2
7. National income	280.6	294.7	318.4	353.9	372.8	415.5
8. National savings (5-1) or (2+4)	59.6	65.2	66.9	83.0	86.8	105.7
9. Ratio of investment to GNP (per cent)	15.8	15.7	17.0	19.6	20.0	22.3
10. Rate of growth of GNP (per cent)		5.3	7.5	12.1	6.0	11.8

Source: Bank Markazi Iran, National Income of Iran (1962-67), Tehran, September 1969, Table 51, p. 70.

[1] Oil companies are treated as domestic residents in the determination of net exports.

<u>Growth Factors</u>: The high growth rate during the Third Plan was largely due to the increasing development effort which was reflected in the sizable increase in total investment. Gross domestic fixed capital expenditures more than doubled (from Rls. 49 billion in 1962 to Rls. 108 billion in 1967) rising from 15.3 per cent of GNP in 1962 to 22.3 per cent of GNP in 1967. Almost two-thirds of this increase was in public sector investments which increased from about one-third of total investment in 1962 up to almost half in 1967. Private investments increased sharply in 1964 (20 per cent) reflecting a revival of business activity after the recession which ended in 1963. From 1964 to 1967, there was a gradual slow-down in the rate of increase of private sector investments (from 20 per cent in 1964 to 8.5 per cent in 1967).

A factor that has contributed to the high rate of growth during the Third Plan was the incremental capital/output ratio which averaged 2.6, which was low in comparison to other developing countries. This low capital/output ratio was explained to some extent by the existence of under-utilized capacity at the beginning of the period and by the relatively large increases in the value-added in the petroleum production which were not primarily due to increased investment. However, it also reflected the increase in quick-yielding investments, particularly in the private sector.

Based on statistics in constant prices for the five years ending in 1967, the increases in domestic saving have not kept pace with the increases in domestic investment. In 1962 national saving amounted to Rls. 59.6 billion with Rls. 49.3 billion of this being invested domestically while the remainder was invested in foreign assets. In 1967 national saving had increased to Rls. 105.7 billion but domestic investment amounted to Rls. 108.3 billion; thus there was a foreign disinvestment of Rls. 2.6 billion through the current account. This development occurred even though the average saving ratio (national saving/national income) had increased from 0.21 in 1962 to 0.25 in 1967. Thus the rapid increases in domestic investment was creating pressures on domestic resources to the extent that disinvestment of foreign assets through the current account resulted.

One of the major problems encountered in the mobilization of saving was the large increases in public investment which had to be financed by private domestic saving. Saving through the budget in current prices increased sharply from Rls 11.2 billion in 1963 up to Rls. 27.7 billion in 1964 but did not rise significantly above this latter level in the succeeding years. Thus the amount of public sector investments that were financed by private domestic saving more than tripled. In addition, there was a sharp increase in borrowing from the banking system and in the utilization of foreign loans in 1966 and 1967.

Major Sectors of the Economy: As shown in Table III-2, all major sectors of the economy contributed to its expansion during the Third Plan. The fastest growing sector was public administration and defense which increased at a compounded annual rate of about 15 per cent. Of the production sectors, both the petroleum industry and manufacturing increased rapidly (by 13.5 per cent and 11.2 per cent per annum, respectively) while the growth in agriculture was relatively low (about 4.2 per cent per annum). The growth rate in GNP for 1966 (based on GNE) is probably understated due to the marked change in statistical discrepancies from 1965 to 1966. The change in statistical discrepancies came about due to the utilization of new census and expenditure data developed during 1965 and 1966. It should also be noted that the share of the petroleum sector in GDP indicated in Table III-2 is overstated due to the computing of the oil production at posted prices rather than actual market prices.[1] The over-valuation is offset by a corresponding overstatement of profit remittances of foreign-owned oil companies (which was the main component of the item "net factor payments to abroad"). The share of the petroleum sector in gross

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[1]The oil pricing system has been very complicated since its very beginning. There are a lot of misleadings resulted from over-sophisticated formula for oil pricing. However, posted price and market price of oil are two rather hypothetical prices which are publicized. For more information, see H. J. Frank, Crude Oil Prices in the Middle East: A Study in Oligopolistic Price Behavior, (New York: F. A. Praeger, publisher, 1966).

national product (value added in domestic production less profit remittances of foreign-owned oil companies) increased from 12 per cent in 1962 to 16 per cent in 1967. By comparison, the share of industry in gross national product during the same period showed a small increase from 9.2 per cent to 10.5 per cent while the share of agriculture declined from 27.4 per cent to 22 per cent.

Table III-2

Gross National Product By the Economic Sectors During the Third Plan

(in billions rials at constant prices of 1959)

	1962	1963	1964	1965	1966	1967
Agriculture	88.3	89.9	92.2	99.0	102.8	110.9
Industry	29.5	32.1	36.2	39.2	44.6	50.3
Petroleum[1]	65.5	73.8	75.6	87.6	98.7	123.0
Construction	13.4	15.0	16.2	19.6	20.2	25.0
Transportation and communication	23.6	24.5	25.4	26.3	27.3	28.2
Wholesale and retail trade	34.4	35.8	38.3	41.0	42.9	47.6
Public administration and defense	24.4	27.2	32.2	41.2	46.0	48.7
Private services	15.1	15.9	17.0	18.0	19.3	21.1
Others	29.1	32.1	36.1	40.5	46.3	50.0
Statistical discrepancies	10.7	7.3	5.6	7.7	-3.4	-5.6
Gross domestic product (GDP) at factor cost	334.0	353.6	374.8	420.1	444.7	499.2
Plus: Indirect taxes	19.0	20.8	20.7	26.1	30.1	35.2
Less: Net factor payment to abroad[2]	30.9	35.2	30.9	37.4	41.5	49.7
Gross national product at market prices	322.1	339.2	364.6	408.8	433.3	484.7

Source: Bank Markazi Iran, National Income of Iran (1962-67), Tehran, September 1969.

[1]Value added in domestic production of the oil sector.

[2]Including mainly profit remittances of foreign-owned oil companies.

The Third Plan was the first which was deemed to have some aspects of so-called development plans. The implementation of this plan coincided with a series of major social transformations as well as economic reforms. These transformations included: the implementation of a land reform program, the participation of industrial workers in the net profits of the enterprises they work for, the nationalization of forests, the establishment of the Literacy Corps, Health Corps and Development and Extension Corps, public sale of state-owned industrial enterprises, an administrative and educational reorganization, and the attainment of civil rights for women.

This collection which was later on increased to twelve (by adding the establishment of rural courts, nationalization of the country's water resources and reconstruction program in urban and rural areas) is called the White Revolution.[1] In addition, in the span of the Third Plan steps were taken to establish basic industries such as steel, petrochemicals, aluminum-smelting, machine-tool, tractor and pipe construction. With respect to agriculture, major irrigation networks were established through the construction of diversion dams. There were also achievements in other fields such as communication, transportation, health and education.

Finally, the mobilization of the forgotten humanpower

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[1]The size of White Revolution has been increased recently by including some other points.

was another goal of the Third Plan which could not be achieved at an acceptable level. While the annual growth rate of GNP was 9 per cent, with population growing at 2.8 per cent, the annual average growth rate of humanpower was only 2.2 per cent (Tables III-3 and III-4).

Therefore, considering the economy, which was based mainly on agriculture and other labor-intensive activities, the growth rate of humanpower much less than that of the GNP could imply the overall constrain imposed by humanpower on the economic growth. Moreover, the 7-8 per cent annual growth rate of unemployment during the Third Plan doubtlessly talks of misallocation of human resources. These in addition to other socio-political considerations made the planners think of a humanpower plan more seriously in the forthcoming plan.

Table III-3

Humanpower Employment by the Economic Sectors
During the Third Plan

(1000 Man-Year)

	1962	1963	1964	1965	1966	1967
Agriculture	3,261	3,242	3,221	3,197	3,168	3,141
Industry	1,520	1,589	1,660	1,735	1,813	1,891
Oil	44	45	45	45	44	46
Services	1,494	1,546	1,597	1,652	1,706	1,762
Unemployment	600	651	704	759	818	874
Total	6,919	7,073	7,227	7,388	7,549	7,714

Source: Central Bank of Iran, National Income of Iran 1962-67, p. 58.

Table III-4

Index of Humanpower Employment by the Economic Sectors During the Third Plan

	1962	1963	1964	1965	1966	1967	Annual average growth rate
Agriculture	100.0	99.4	98.8	98.0	97.1	96.3	-0.8
Industry	100.0	104.5	109.2	114.1	119.3	124.4	4.5
Oil	100.0	102.3	102.3	102.3	100.0	104.5	0.9
Services	100.0	103.5	106.9	110.6	114.2	117.9	3.3
Unemployment	100.0	108.5	117.3	126.5	136.3	145.7	7.8
Total	100.0	102.2	104.5	106.8	109.1	11.5	2.2

Source: Central Bank of Iran, National Income of Iran (1962-67) p. 58.

4. The Fourth Development Plan (March 1968-March 1973)

The Fourth Plan was considered to be a turning point in the history of the Iranian economy in terms of both its technical nature and the economic growth that was expected. The general goals of this plan were: stressing industrialization, development of agriculture and raising of farmers' income so as to avoid the migration of rural families to cities.

Another goal of the Fourth Plan was to raise public welfare and propagating social services among different social groups, especially low-income groups.

The Fourth Plan exceeded its predecessors in terms of the level of investment and expenditure envisaged. It put the volume of public sector development activity 768 billion rials, i.e. more than three times as much as the level of development expenditure envisaged under the Third Plan. This, in addition to investment on the part of the private sector was expected to raise national income from about 457.8 billion rials at the end of the Third Plan to 868 billion rials at the end of the Fourth Plan. In other words, it was envisaged that the economy to grow at an average annual rate of 9.4 per cent and that national income to increase by about 57 per cent over the five-year period.

The Economic Performance of Iran During the Fourth Plan

National Product: The implementation of the Fourth

Plan resulted in the expansion of economic activities in both public and private sectors. During the Plan-period, gross national product at constant prices increased from Rls 513.8 billion in 1967 to Rls 889 billion in 1972, implying, an average annual growth rate of 11.6 percent. Thus, the actual growth rate exceeded by 2.2 percentage units the growth rate target by 9.4 percent. Over the same period of time per capita GNP increased from Rls 20,983 rials ($277) in 1967 to Rls 38,855 ($513 and $556, respectively, on the basis of the old and the new parity rates) in the final year of the Fourth Plan period (Table III-5).

During the Fourth Plan period, the relative share of agriculture in GNP declined by 6.5 percentage units; while the relative shares of services, national oil, and industries and mines increased respectively by 3.6, 2.1 and 0.9 percentage units. As a result, agriculture, which in 1967 made the greatest contribution to GNP, lost its most important relative position to industries and mines (Table III-6).

The agricultural value added at constant prices increased from Rls 111.1 billion in 1967 to Rls 134.4 billion in 1972, implying an average annual growth rate of 3.9 percent. The Fourth Plan's growth target for agriculture, however, was not realized, as the actual rate fell short of the planned rate by 0.5 percentage units. The

Table III-5

Gross National Product of Iran During the Fourth Plan
(in billion rials at constant prices of 1959)

	1968	1969	1970	1971	1972	Average annual growth rate 1967-72 (percent)	Growth target of the Fourth Plan (percent)	Share in GNP in 1972 (percent) Target	Actual
1. Consumption expenditures	457.0	501.5	558.2	610.7	708.9	11.9	7.4	75.1	79.7
Private sector	370.3	397.7	437.8	451.4	503.8	8.8	6.7	56.7	56.6
Public sector	86.7	103.8	120.4	159.3	205.1	22.8	9.8	18.4	23.1
2. Gross domestic fixed capital formation	126.3	131.8	139.7	179.3	211.7	13.4	13.6	25.3	23.8
Private sector	55.9	52.5	56.3	77.7	91.7	9.6	-	-	10.3
Public sector	70.4	79.3	83.4	101.6	120.0	16.8	-	-	13.5
3. Current account of balance of payments	-13.9	-11.7	-8.2	-11.6	-31.6	55.3	-	-0.4	-3.5
4. Gross national product	569.4	621.6	689.7	778.4	889.0	11.6	9.4	100.0	100.0
5. National savings	112.4	120.1	131.5	167.7	180.1	10.4	17.2		
6. Percentage ratio of (5) to (4)	19.7	19.3	19.1	21.5	20.3				
7. Percentage ratio of (2) to (4)	22.2	21.2	20.3	23.0	23.8				
8. Percentage ratio of (5) to (2)	89.0	91.1	94.1	93.5	85.1				

Source: Bank Markazi Iran, Annual Report and Balance Sheet 1351 (1972), (Tehran: September 1973), p. 144.

Table III-6

Gross National Product By the Economic Sectors During the Fourth Plan

(in billion rials at constant prices of 1959)

	Value added						Average annual growth rate 1968-72 (percent)		Share in the GNP (percent)		
	1967	1968	1969	1970	1971	1972	Actual	Target of the Fourth Plan	1968	1972	Average share 1968-72
1. Agriculture	111.1	119.7	123.4	129.1	124.4	134.4	3.9	4.4	22.5	16.0	19.0
2. National oil	80.8	92.4	105.4	121.4	144.5	163.7	15.2	15.3	17.4	19.5	18.8
3. Industry and mining	106.3	119.8	130.9	144.4	170.6	195.9	13.0	12.4	22.5	23.4	22.9
Industries and mines	(72.5)	(82.8)	(90.9)	(100.9)	(118.1)	(138.1)	13.8	13.0	(15.6)	(16.5)	(16.0)
Construction	(24.9)	(26.2)	(26.6)	(27.3)	(33.0)	(35.0)	7.1	9.9	(4.9)	(4.2)	(4.4)
Water	(1.0)	(1.0)	(1.2)	(1.4)	(1.6)	(1.7)	11.2(1)	16.8	(0.2)	(0.2)	(0.2)
Electricity	(7.9)	(9.8)	(12.2)	(14.8)	(17.9)	(21.1)	21.7		(1.8)	2.5	(2.3)
4. Services	187.0	212.0	235.2	268.2	310.6	363.9	14.2	7.5	39.9	43.5	(41.8)
Transportation and communication	(35.6)	(37.5)	(40.0)	(44.7)	(46.7)	(53.8)	8.6		(7.1)	(6.4)	(6.7)
Banking, insurance and brokerage fees	(13.7)	(18.3)	(23.5)	(30.3)	(35.4)	(46.3)	27.6		(3.5)	(5.5)	(4.6)
Domestic trade	(39.8)	(43.1)	(46.8)	(51.2)	(56.2)	(62.5)	9.4		(8.1)	(7.5)	(7.8)
Rent	(27.7)	(29.9)	(31.9)	(34.1)	(36.7)	(39.9)	7.6		(5.6)	(4.8)	(5.2)
Public Services	(48.6)	(57.1)	(64.4)	(75.7)	(97.1)	(118.6)	19.5		(10.7)	(14.2)	(12.4)
Private services	(21.6)	(26.1)	(28.6)	(32.2)	(38.5)	(42.8)	14.7		(4.9)	(5.1)	(5.1)
5. Net factor income from abroad (excluding oil)	-5.8	-12.0	-13.6	-16.8	-19.3	-20.1	28.2		-2.3	-2.4	-2.5
6. GNP (1+2+3+4+5)	479.4	531.9	581.3	646.3	730.8	837.8	11.8	9.4	100.0	100.0	100.0
7. Indirect (taxes(net)	34.4	37.5	40.3	43.4	47.6	51.2	8.3				
8. GNP (at market cost) (6+7)	513.8	569.4	621.6	689.7	778.4	889.0	11.6	9.4			

(1) Average annual growth rate of water and electricity.

Source: Bank Markazi Iran, Annual Report and Balance Sheet 1351 (1972), (Tehran: September 1973), p. 143.

share of the agricultural value added in GNP declined from 22.5 percent in 1968 to 16 percent in 1972.

Value added in industries and mines, which during the period under review accounted for about 23 percent of GNP, increased from Rls. 106.3 billion in 1967 to Rls. 195.9 billion in 1972. The actual average annual growth rate of value added in industries and mines amounted to 13 percent, or 0.6 percent higher than the Fourth Plan's target rate. The growth rate of value added in industries and mines fluctuated between 9.2 percent in 1969 and 18.2 percent in 1971. As a result of the rapid growth of industries and mines, the relative share of this sector in GNP increased from 22.5 percent in 1967 to 23.4 percent by the final year of the Plan-period.

During the Fourth Plan period, changes occurred in Iran's oil industry. In October 1970, the income tax rate applicable to the Iranian Oil Operating Companies (Consortium) was raised from 50 to 55 percent. At the same time, the posted price of the heavy crude was raised by 9 U.S. cents per barrel. Subsequently, in February 1970, on the basis of the Agreement signed in the Tehran Conference the price of the heavy crude, increasing by 40.5 U.S. cents per barrel, was raised from $1.72 to $2.125 per barrel; while the price of the light crude increased from $1.79 to $2.17, reflecting a rise of 38 U.S. cents per barrel. As a result, the value added in national oil at constant prices was more than doubled, increasing from Rls. 80.8 billion in 1967 to Rls. 163.7 billion in 1972.

During the period under consideration, value added in national oil grew at an average rate of 15.2 percent, or almost at the planned rate. The value added growth rate of national oil fluctuated from 14.1 percent in 1969 to 18.9 percent in 1971. The share of national oil in GNP increased from 17.4 percent in the initial year of the Plan-period to 19.5 percent in 1972.

Value added in services, in line with production and employment increases in the economy, more than doubled, increasing from Rls 187 billion in 1967 to Rls 363.9 billion in 1972. Value added in services grew at an average annual rate of 14.2 percent, exceeding the growth target by 6.7 percentage units. The relative share of services in GNP increased from 39.9 percent in the first year of the Plan-period to 43.5 percent in 1972. The value added growth rate in services exceeded 13 percent in every year during the Plan-period, except in 1969 when it was only 11 percent.

During the period under consideration, the number of persons employed increased from 7.9 million in 1967 to 9.1 million by the end of 1972, implying an average annual rate of increase of about 3 percent in total employment in the economy.

The Fourth Plan had envisaged a 6.7 percent increase in agricultural employment. In practice, however, agricultural employment actually declined by 5 percent. During the same period of time, employment in industries and mines, and services increased by 38 percent and 36 percent, respectively; implying over-fulfillment of the Fourth Plan's relevant targets by 13 and 19 percentage units. The share of agriculture in total employment fell, by 8.9 percentage units, to 40.1 percent by the end of the Fourth Plan period. On the other hand, the relative share of industries and mines increased from 24.7 percent to 29.4 percent, while that of services rose from 25.7 percent to 30 percent respectively.

The active population of Iran rose from 8.1 million in 1967 to 9.2 million in 1972; at the same time the ratio of active population to total population declined from 30 percent in 1967 to 29.5 percent in 1972. This, in addition to discrepancies between planned and actual employment in various sectors of the economy (Table III-7) made it evident that the humanpower plan and/or its execution was not accurately made.

Table III-7

Employment By the Three Main Economic Groups During the Fourth Plan

(1000 Man-Year)

	1967		1972		Total change 1967-1972	
	Number	Share (percent)	Number	Share (percent)	Actual	Planned
Agriculture	3,861	49.0	3,659	40.1	-202	226
Industry and mining	1,993	25.3	2,730	29.9	737	417
Services	2,020	25.7	2,740	30.0	720	323
Total	7,874	100.0	9,129	100.0	1,255	966

Source: Bank Markazi Iran, Annual Report and Balance Sheet 1972, p. 214.

5. The Fifth Development Plan (March 1973-March 1978)

The Fifth Plan of Iran being started in March 1973 is distinguishable from its predecessors not only by the size of public investments but also by the inclusion of private sector's investment as well. The Plan initially called for total investments of 2,461 billion rials ($36.4 billion)[1] during its five-year period. Of the total, 1,549 billion rials ($13.5 billion) are from private sector investment. The bulk of public sector investment are to be financed by anticipated total oil revenues of about $24.6 billion in the Fifth Plan period.

Decisions taken by the Organization of Petroleum Exporting Countries (OPEC) in October and December 1973, and subsequent developments in the international oil market had the effect of almost quadrupling Iran's per barrel oil revenues. As a result, revenues estimated from the oil sector in the Fifth Plan period were revised upward to a new figure of $98.2 billion.

The huge jump in oil income permitted a revision of all sectors of the Fifth Plan and greatly increased spending on economic development, social welfare, defence infrastructure and public administration. The revised Fifth Plan, providing for a near doubling of investments, was submitted to parliament in December 1974 (Table III-8).

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[1] The rate of exchange applied for conversion of rials into dollars is $1 = 67.5 rials.

Table III-8

Fixed Investment in the Fifth Plan (in billion rials)

Title	Public sector	Private sector	Total
Public Affairs	380.56	---	380.56
Imperial Court	---	---	---
Legislative branch	---	---	---
General administration	0.70	---	0.70
Judiciary	1.96	---	1.96
Implementation of domestic policy	0.40	---	0.40
Domestic security	0.60	---	0.60
International relations	---	---	---
Financial administration	1.00	---	1.00
Statistical and technical services	30.00	---	30.00
Information and mass media	26.90	---	26.90
Government buildings and facilities	319.00	---	319.00
Manpower administration	---	---	---
Defence			
Social Affairs	591.52	694.85	1,286.37
Education	126.77	4.80	131.57
Arts and culture	9.10	1.00	10.10
Health, medical care and nutrition	42.05	3.65	45.70
Welfare	9.00	---	9.00
Physical education, scouting and youth affairs	15.00	0.40	15.40
Urban development	73.50	---	73.50
Rural development	60.00	---	60.00
Housing	240.00	685.00	925.00
Environmental conservation	6.10	---	6.10
Multi-purpose regional development	10.00	---	10.00
Economic Affairs	2,146.49	885.38	3,031.87
Agriculture and natural resources	176.85	132.40	309.25
Water	162.24	4.00	166.24
Electricity	310.50	---	310.50
Industry	277.14	503.00	780.14
Oil	535.90	87.80	623.70
Gas	120.00	47.50	167.50
Mines	61.80	4.50	66.30
Transport and communications	402.20	90.00	492.20
Post and telecommunications	91.30	---	91.30
Tourism	8.46	16.18	24.64
Commerce	0.10	---	0.10
Grand Total	3,118.57	1,580.23	4,698.80

Source: Plan Organization, Fifth Development Plan of Iran, Tehran, 1975.

[1] In 1975, the private ownership of educational institutions, at all levels, were transferred to the public sector. Therefore, the amount of 4.80 billion rials for fixed investment in education by private sector is to be added to the corresponding item of public sector.

The general aims of the plan are mentioned as:

> to improve living standards and incomes, particularly of low-income groups; achieve continuous, balanced growth with minimum inflation; improve social services and spread social justice; protect the environment; distribute manpower resources more evenly; spread scientific knowledge and technology; increase domestic production and industrial imports; invest surplus foreign exchange abroad to create new sources of wealth for the post-petroleum era; and preserve and promote the national culture and heritage.[1]

Thus, the allocation of resources in the Fifth Plan is envisaged to ensure balanced growth between different sectors and various regions of the country. However, greater emphasis is placed on investment in the key sectors such as agriculture, basic industries (particularly petrochemicals) and some other areas deemed to be of infrastructure nature.

The following tables show the expected amount of value added in four aggregated sectors of the economy and their share in GDP at the end of the Fourth and Fifth Plans respectively.

Table III-9

Value Added of Major Economic Sectors (at Fixed Prices of 1972)

Aggregated Sectors	1972	1977	Annual growth rate (%)
Agriculture	201.1	282.1	7.0
Oil	216.5	1,712.0	51.5
Industries & Mines	247.4	566.0	18.0
Services	445.8	953.9	16.4
GDP	1,110.8	3,514.0	25.9

Source: Plan & Budget Organization, Fifth Development Plan, Tehran, 1975.

[1] Kayhan, A Guide to Iran's Fifth Plan (1973-78), Tehran, pp. 9, 10.

Table III-10

Share of Major Economic Sectors in GDP at the End of the Fourth and Fifth Plans (Fixed Prices of 1972)

	1972	1977	Annual Rate of Change (%)
Agriculture	18.1	8.0	-2.2
Oil	19.5	48.7	+5.9
Industries & Mines	22.3	16.1	-1.2
Services	40.1	27.2	-2.5
Total	100.00	100.0	0

Source: Plan & Budget Organization, Fifth Development Plan, Tehran, 1975.

Assuming no downward drastic change in the oil revenue and other financial sources of the Fifth Plan, the planned rates of growth in various sectors of the economy is envisaged through the provision of the humanpower needed for the expected operation of the economy. Unfortunately, according to the predicted supply and demand for the plan period (Table III-11), there exists a shortage of humanpower of all types except in sales administration and transport branches. This being the case, the significance of the humanpower, especially the qualified one, becomes evident.

Table III-11

(1000 Man-Year)

Changes in Supply and Demand and Shortage of Humanpower in the Fifth Plan

	Δ Demand	Δ Supply	Shortage
ENGINEERS			
Architects, civil	7.8	4.0	3.8
Electric and electronics	5.5	2.8	2.7
Mechanical	6.9	4.2	2.7
Chemical, mining and metallurgy	2.0	1.0	1.0
Others	14.2	8.3	5.9
MEDICAL CADRES			
Physicians	8.5	7.2	1.3
Others	35.6	14.3	21.3
EDUCATIONAL CADRES	287.4	230.0	57.4
MANAGEMENT LEVEL	22.5	21.0	1.5
TECHNICIANS	116.6	75.0	41.6
OTHER TECHNICAL AND SKILLED CADRES	8.0	4.0	4.0
ADMINISTRATIVE AND CLERICAL, SALES	185	185	--
MINERS	23.0	15.0	8.0
TRANSPORT	41.0	41.0	--
SKILLED AND SEMI-SKILLED WORKERS	520	230	290
SKILLED CONSTRUCTION WORKERS	290	20.0	270.0
UNSKILLED WORKERS	538	528	10.0
TOTAL	2,112.0	1,390.8	721.2

Source: Plan & Budget Organization, The Fifth Development Plan, Tehran, 1975.

SUMMARY - III

Thanks to the tremendous oil revenue during the last recent years, Iran, like any other oil producing country, has been enjoying an unusual autonomous economic growth. Such an upraising trend may exist as long as the world's situation, generally, and Iran's condition specifically, follow a similar pattern in the future. Although lots of unpredictable elements are involved in this respect the fact that oil, like any other natural resources, would be depleted sooner or later is completely predictable.[1] Hence, *ceteris paribus*, the autonomous growth would not be lasting unless it is converted to an endogeneous growth. This notion will take us back to the theoretical foundation of growth and development, that a lasting economic growth could result when it is backed by economic development.

In the discussion of economic development the factors of development are classified as static and dynamic ones. In other words, the guardians of a lasting economic growth are considered as physical resources and qualified human-power or what we termed as "strategic growth agents." It is perceivable to categorize different countries on the basis of their relative accessibility to these two factors. Naturally, we will find four general types: (1) Countries

[1] Although no specific date is officially stated for the depletion of Iran's known oil reservoirs, considering the current rate of extraction it might not be longer than 10 to 15 years.

enjoying a good level of both resources such as U.S. and U.S.S.R.; (2) countries with rich human resources such as Japan and China; (3) countries with relatively good level of physical (or natural) resources such as Kuwait and (4) countries with relatively low level of both like most of LDC's.

Except for the first category wherein a good amount of combination of both resources exists, in the other two categories, a substitution between the two resources is necessary. However, in addition to the fact that substitutability between those factors is not unlimited, the third category of countries is facing another constraint, mainly the limited capacity of their natural resource reservoirs. Turning back to the country under our study, Iran, we realize that, so far, oil revenues have made up for many shortcomings in the strategic growth agents in the process of its economic growth. In other words, the substitution of oil revenues for human ones has yielded the country a far higher rate of growth than it could have, if this natural resource flow did not exist. The availability of foreign exchange have made it possible not only to feel less need to strive for obtaining foreign exchange from other channels, but also to substitute the oil-earned-foreign-exchange for domestic savings in the process of its growth and hence invalidating the two-gap theories of growth.[1] Nevertheless, in this area too, domestic infrastructure capacity and inflation (both domestically generated as well as imported ones) have exercised significant constraints.

To sum up our discussion, we should note the point that mostly referred to but leastly taken seriously, viz., the continued development of the Iranian economy depends to a large extent on increasing quantity and quality of the strategic growth agents. This need is envisaged in the Fifth Plan as is depicted in Table III-11 and could be confirmed by looking at the increasing ICOR's in the last three consecutive plans (Table III-12). Therefore, the availability of the right number of the right persons in the right time and the right place deserves the highest degree of attention to be paid both by theoricians and practitioners. As is the case in the medical world, the main job of a physician is the recognition of the disease and prescribing the appropriate treatment; in the economic world, also, the identification of needs and their measurement come before any policy making. In the course of development, the identification of requirements is inevitable. This job, though not easy, could be

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[1]Before the oil price increase and hence prevailing of almost unabsorbable amount of foreign exchange, the two-gap model was applicable to the case of Iran. See G. H. Baher, "The Two-Gap Theory of Development and a Two-Gap Projection Model for Iran", forthcoming in the Journal of Economic Research.

Table III-12

Iran's GNP and ICOR at the End of the Last Three Consecutive Plans

	1967 (actual)	1972 (actual)	1977 (expected)	Growth rate/ 4th Plan(%)	Growth rate/ 5th Plan(%)
A. Consumption expenditures	540	898	2,168	10.7	19.3
1. Private sector	(442)	(645)	(1,322)	(7.9)	(15.4)
2. Public sector	(98)	(253)	(846)	(20.8)	(27.3)
B. Gross fixed investment	151	287	1,052	13.7	29.7
1. Private sector	(77)	(141)	(319)	(12.9)	(17.7)
2. Public sector	(74)	(146)	(734)	(14.6)	(38.1)
C. Balance of payments on current accounts	-5	-20	465	--	--
D. GNP at current prices	686	1,165	3,686	11.2	25.9
E. Population in millions	26.5	31.0	35.9	3.0	2.9
F. Per capita GNP in rials	25,894	37,522	102,665	8.2	23.0
G. Per capita GNP in U.S. dollars	384	556	1,521	8.2	23.0
H. Incremental capital/ output ratio	0.22	0.25	0.29	14	16

Source: Plan and Budget Organization, Fifth Development Plan of Iran, Tehran, 1975.

handled with the cooperation of various people. Considering the qualified humanpower as the most wanted factor for the economic development of Iran, in what follows we will try to contribute our share to enhancing the purpose of development.

CHAPTER IV

PLANNING MODELS FOR THE STRATEGIC GROWTH AGENTS

It is not much longer than a decade that economists have started to think of planning the qualified humanpower in a serious way. Despite the short length of this period, the planning models, in this ground, have evolved from very simplified types to most sophisticated ones. In this chapter we review briefly the evolution of models suggested both to measure and to predict the requirement of strategic humanpower in the process of development.

1. Harbison's Rule-of-Thumb

Assuming that the rates of growth of qualified humanpower and the growth of GNP are correlated, Harbison believes that the number of secondary (N^2) and higher level educated people (N^3) should grow respectively three and two times as fast as GNP or ($\dot{Y}$)[1]:

$$\dot{N}^2 = 3\dot{Y} \quad (1)$$

$$\dot{N}^3 = 2\dot{Y} \quad (2)$$

There are two major questions here:

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[1] F. H. Harbison and C. A. Myers, Education, Manpower and Economic Growth (New York: McGraw-Hill, 1964), pp. 23-48 and 173-87.

a. why is the relation between growth rates of the third level and secondary level educated people to the growth rate of GNP chosen to be 2:1 and 3:1 and not something else?

b. Is the rate of growth of GNP the only determining factor for the growth rate of required educated people?

Mark Blaug, in questioning the looseness of Harbison's rule-of-thumb, states that: "No national and certainly no international comparative evidence was ever published, either by Harbison or by anyone else, to justify the famous 2:1 and 3:1 ratios."[1]

It is also argued that the Harbison's rule-of-thumb does not make sense even from a theoretical point of view.[2] The only international evidence which exists in this regard is the findings of the Netherlands Economic Institute (N.E.I.).[3]

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[1]M. Blaug, An Introduction to the Economics of Education, Penguin Books, 1970 (reissued in 1972), p. 73.

[2]See E. R. Rado and A. R. Jolly, "The Demand for Manpower: An East African Case Study," Journal of Development Studies (April 1965), pp. 80-84.

[3]Netherlands Economic Institute, "Financial Aspects of Educational Expansion in Developing Regions: Some Quantitative Estimates," in Financing of Education for Economic Growth (Paris: O.E.C.D., 1966).

2. N.E.I.'s Naive Demand Model

In order to build demand equations for educated labor the N.E.I. ran the following regressions on 1957 data over twenty-three countries (half of which from LDC's):

$$N^2 = \alpha_2(Y)^{\beta_2} \left(\frac{Y}{N}\right)^{\gamma_2} \quad (3)$$

$$N^3 = \alpha_3(Y)^{\beta_3} \left(\frac{Y}{N}\right)^{\gamma_3} \quad (4)$$

where: N^2 = active labor force with secondary education (second level)

N^3 = active labor force with higher education (third level)

Y = national income in 1957 (at current prices in U.S. dollars)

N = population

α's, β's and γ's = constants to be estimated.

The estimated equations were:[1]

$$N^2 = 163.67\ Y^{1.314} \left(\frac{Y}{N}\right)^{-0.655} \quad (R^2 = 0.857) \quad (5)$$

$$N^3 = 5.20\ Y^{1.202} \left(\frac{Y}{N}\right)^{-0.164} \quad (R^2 = 0.845) \quad (6)$$

These equations could be rewritten in terms of N and Y as:

$$N^2 = 163.67\ Y^{0.659}\ N^{0.655} \quad (7)$$

$$N^3 = 5.20\ Y^{1.038}\ N^{0.164} \quad (8)$$

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[1] In a complementary research work, N.E.I. has produced a slightly different equation: see "The Educational Structure of the Labour Force. A Statistical Analysis" (Rotterdam: Netherlands Economic Institutes, 1966).

If we write these equations in logarithmic form and assume the cross-section estimates behave the same as time series estimates, by differentiating the logarithmic equations with respect to time, we find relations between the growth rates of N, Y, N^2 and N^3 as follows:[1]

$$\dot{N}^2 = 0.659\ \dot{Y} + 0.655\ \dot{N} \qquad (9)$$

$$\dot{N}^3 = 1.038\ \dot{Y} + 0.164\ \dot{N} \qquad (10)$$

The final equations (9 and 10) show that a one per cent increase in national income is associated with 0.659 per cent and 1.038 per cent increase in N^2 and N^3 respectively. In other words, Harbison's off-base ratios 3:1 and 2:1 are replaced with N.E.I.'s partially-based ratios $\frac{2}{3}$:1 and 1:1.

As a major comment to this approach it could be mentioned that the N.E.I.'s so-called regression equations could be considered at the best as associations in which no causality is specified. In other words, neither the relationships between variables nor the form of the equations have been based on a sound theoretical basis.

3. Tinbergen's Balanced Growth Model

A controversial model for planning the requirement of qualified humanpower is suggested by Correa and Tinbergen to predict the requirement of the economic development to the

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[1]The method used for finding the growth rates could be shown as:

$$\frac{d\log N}{dt} = \frac{1}{N} \cdot \frac{dN}{dt} = \frac{\frac{dN}{dt}}{N} = \dot{N}$$

secondary and third level educated people in the context of a balanced growth.[1] The sophisticated version of this model which modified later on by Tinbergen and Bos (Tinbergen's Balanced Growth Model) could be shown as follows[2]:

Format of the Model

$$N_t^2 = \nu^2 V_t \qquad (1)$$

$$N_t^2 = N_{t-1}^2 - m_{t-T^2}^2 + m_t^2 \qquad (2)$$

$$m_t^2 = \mu^{21} n_{t-1}^2 + \mu^{22} n_{t-1}^3 - n_t^3 \qquad (3)$$

$$m_t^3 = \mu^3 n_{t-1}^3 \qquad (4)$$

$$N_t^3 = N_{t-1}^3 - m_{t-T^3}^3 + m_t^3 \qquad (5)$$

$$N_t^3 = \nu^3 V_t + \pi^2 n_t^2 + \pi^3 n_t^3 \qquad (6)$$

where:

V = total volume of production (income) [illegible] the country

N^2 = the labor force with a secondary education in current period

N^3 = the labor force with a third-level education in current period

m^2 = those who entered the labor force N^2 within the previous 6-year period

m^3 = those who entered the labor force N^3 within the previous 6-year period

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[1] H. Correa and J. Tinbergen, "Quantitative Adaptation of Education to Accelerated Growth," Kyklos, Vol. XV (1962), p. 776.

[2] Jan Tinbergen and H. C. Bos, "A Planning Model for the Educational Requirements of Economic Development," in The Residual Factor and Economic Growth, (Paris: O.C.E.D., 1964), pp. 147-69.

n^2 = the number of students in secondary education

n^3 = the number of students in third-level education

ν^2&ν^3 = fixed coefficients which determine the relationships between production and the labor force with a secondary education and third-level education respectively

μ^{21} = a fraction of one period earlier secondary students who join the labor force

μ^{22} = the proportion of third-level students who do not complete their studies and join the labor force ("drop-outs")

μ^3 = the proportion of students completing their third-level education who join the labor force

T^2&T^3 = productive life of individuals with a secondary and a third-level of education, respectively

π^2&π^3 = teacher-student ratios at secondary and third-level education, respectively.

Structure of the Model

Equation (1): This equation links the requirements of secondary educated humanpower to the volume of production. This relation has been assumed to be numerically proportional. The parameter ν^2 which relates secondary educated humanpower (N^2) to the volume of gross domestic product (V_t) can be interpreted as the inverse of ordinary labor productivity ratio ("labor coefficient" in input-output terminology), with the modification that it refers to educated humanpower only.[1]

Equations (2) and (5): These equations are identity-type equations which equate, respectively, the stocks of secondary and third-level educated humanpower this period with the stocks of these people one period earlier, plus those who have joined them during the previous 6 years minus those already in the labor force one period earlier who dropped out owing to death or retirement. In these equations, T^2 and T^3 stand for the productive life of individuals with a secondary and a third-level education respectively.

Equations (3) and (4): According to equation (3), the number of persons joining the labor force with a secondary education will be equal to a fraction (μ^{21}) of the number of students enrolled at secondary schools one time-period earlier, plus those third-level students who do not complete their studies[2] with a coefficient (μ^{22}) minus those who have

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[1] Equation (1) in this sense has been treated as a factor requirement function. Following Professor Bombach, O.E.C.D., p. 162, it is possible to interpret that equation in quite a different way, namely as a consumption rather than production function. When people become richer they want to be better educated, regardless of whether they really need this education for their job or for getting higher education for the sake of self-satisfaction. Considering Iranian students, especially the pupils studying in high-schools, there is a high proportion of female students who receive education without any desire to enter a professional career. This being the case, it seems appropriate to infer that the demand for educated people comes from two sources (i) need of production to education (given by equation 1 above) and (ii) consumption of education. The latter is a point that standard fixed coefficient models fail to correct.

[2] Assumed to be numerically proportional to the number of the third-level students one period earlier.

completed their secondary education and continue their studies at the third level.

Equation (4) expresses that the number of persons joining the labor force with a third-level of education as a fraction (μ^3) of the number of students enrolled at the third-level one period earlier.

It is worthwhile to mention that $\mu^{22} < 1-\mu^3$; since $1-\mu^3$ includes both the proportion of third-level students who do not enter the labor force at all and those who do not complete their studies, while μ^{22} includes only the latter proportion.

<u>Equation (6)</u>: This equation is also an identity type of equation which equates the humanpower with a third-level education to the sum total of those employed in production[1] and of those teaching at both levels of education.[2] In this equation, ν^3 is the ratio of third-level graduates to the volume of production and π^2 and π^3 stand for teacher-student ratios at secondary and third-level of education respectively.

Comments

The Balanced Growth model for qualified humanpower requirements is subject to two sorts of objections. A chief

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[1]The number of the third-level graduates employed in the production system is assumed to be proportional to the volume of production.

[2]The numbers of those teaching at secondary and the third-level studies are assumed to be proportional to the number of students on each of these levels.

drawback of this method is the problem of measurement in such a quantitative approach. It is questionable whether it is accurate to measure educated humanpower just by adding the number of individuals with only sub-classification being that of secondary and third-level education. This problem is accentuated by the bias in the age pyramid in favour of younger groups, i.e. the fact that recent graduates just out of educational institutes are equipped with more knowledge than the members of the previous generations.

It could also be argued that this approach concentrates completely on formal education without any weight being placed on the process of on-the-job-learning. This is an analogy with physical capital, but unlike machines, men do learn from experience. The rental of machinery tends to decline uniformly with age, but precisely the opposite is true of human beings for quite a while after they join the labor force.[1]

All in all, fixed coefficient models, such as above, are simply a set of identities consisting of fixed proportions between different variables. The zero substitutability between various humanpowers with different qualities from one hand and between labors and capital on the other are two major drawbacks of this type of models. Furthermore, the absence of labor supply behavior in these models makes them a partial accounting framework instead of a comprehensive

[1] See H. S. Houthakker, "Education and Income," Review of Economics and Statistics, February 1959.

planning model. This being the case, the attention of planners has shifted from these types of approach to more elaborated ones.

4. Cost-Benefit Analysis

Cost-benefit analysis is another sort of approach being made in humanpower planning both in more-developed and less-developed countries.[1] In this approach, education from private and/or social points of view, is treated as an investment, and like any other kind of investment, it is argued that through a careful implementation of this approach it is possible to choose the optimal supply of each skill category by maximizing the returns to education.

However, unlike investment in physical capital, the investment in human capital, or what is referred to as education, is entitled to various costs and benefits which their identification and measurement are not easy as such. Nevertheless, despite the difficulties involved in the application of such an approach, it has been applied increasingly during the last decade. The reason for such a wide application of cost-benefit approach into education might be found in its

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[1]For example, see S. Bowles, 1969. Also, M. Cornoy, "Rates of Return to Schooling in Latin America," Journal of Human Resources, No. 2, 1967, pp. 359-74, and H. H. Thias and M. Cornoy, "Cost-Benefit Analysis in Education: A Case Study on Kenya," Report EC-173, (Washington: Economics Department, I.B.R.D., 1969).

theoretical comprehensiveness. To be more explicit there are mainly two schools of thought in the area of educational planning as follows:

1) Education is a process of enskilling the humanpower and hence should adjust to the demand for humanpower in the labor market.

2) Education is a process to satisfy the private demand for education *per se*.[1]

A sub-classification of each school is made on the basis of the method applied in it. However, as was the case in balanced growth approach, a wide application of a method does not confirm its suitability by any means. Therefore, in order to examine the validity of an approach, we should evaluate its theoretical foundation by examining its underlying assumptions.

Costs and Benefits of Education

Private Costs and Benefits of Education: For the individual, the *benefits* of education consist of earnings' increments and other immediate and long-run changes in utility. Assuming that factors are paid by the value of their marginal products and that education increases

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[1]Although the real life is likely to consist of a combination of these two lines of thought; however, these extremes are of analytical significance. See Richard Layard, "Economic Theories of Educational Planning," in *Essays in Honour of Lord Robbins*, eds. M. H. Peston and B. A. Corry (White Plains: IASP, 1972).

productivity, a direct increase in income over time results from education; this benefit to the individual is modified by the taxes which he must pay on the earnings' increments he receives.

Also, two immediate effects on welfare are to be noted. First, the purchase of education can yield direct consumption benefits when pleasure is derived from the educational process itself. Secondly, because education is a socially very acceptable activity, social pressure is exerted upon young people to obtain additional education. Such pressure can cause young people to experience a decrease in utility if they do not continue with education and an increase in utility if they do. Non-pecuniary benefits accrue over time also. The individual profits by being able to enjoy skills and knowledge acquired through education. Literacy as an intensified awareness and understanding of oneself and one's environment is just one of the many possible ways in which an individual's welfare may be augmented by education.

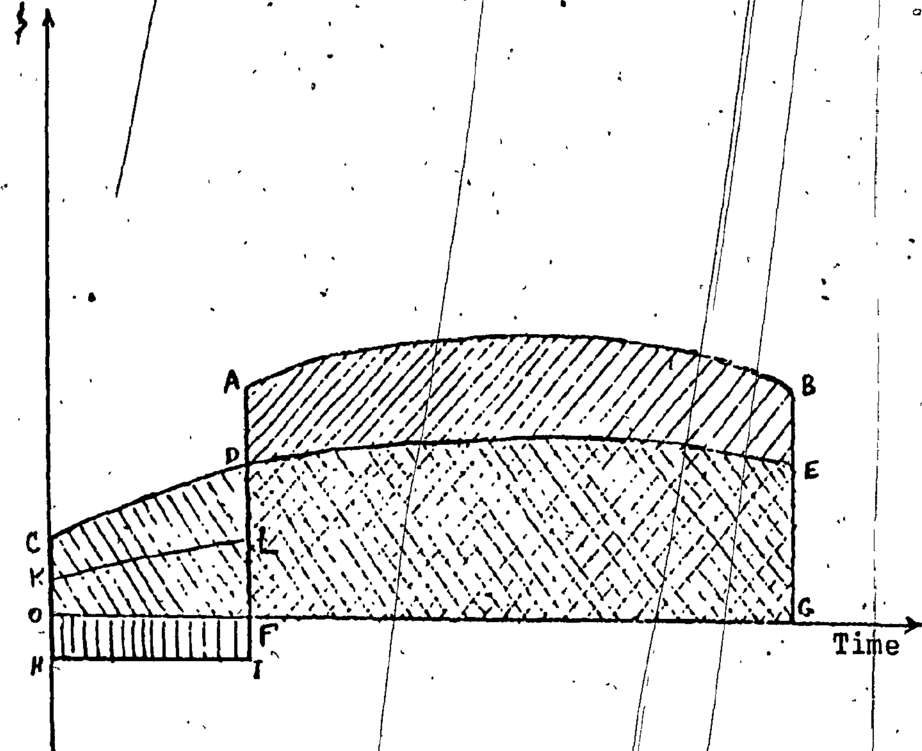
The <u>costs</u> of education to the individual can be divided into two types: (i) direct costs of studying, such as tuition and books, and (ii) potential earnings foregone during the schooling period (minus the taxes which would have been levied on those earnings). Foregone earnings can be measured by comparing earnings of the individual if he works full-time with the case when he chooses to obtain some additional amount of education during the same time. In other words, foregone earnings is equal to the difference between the earnings of the person who is not in school and is making $X and those of the person who is in school (who is also capable of earning $X) and is earning something between $0 and $X, depending on what proportion of his time he spends working.[1]

In order to have a better economic perception of the process of education, the following diagram (Figure IV-1) is designed to illustrate the costs and benefits of education. In so doing, we compare the lifetime financial situation of an individual when he has some base amount of education with the case when he spends some of his time for schooling and then joins the labor market on a full-time basis. In the first case, while he does not undergo any cost for education, his lifetime earnings has a pattern such as the area OCEG. However, if he prefers to have an additional amount of

[1]This method of estimating the value of foregone earnings requires two qualifications. In an economy with sticky wages, one must consider the probability of employment of those who are in school if they were to decide to leave school and enter the work force. This, of course, varies with the current economic conditions and the educational level of the individual. Secondly, this formulation is not adequate if there is a large change in the number of individuals taking the same action -- deciding to enter the labor force rather than to go to school. In the case of such a massive influx of labor into the labor force, the marginal productivity will be significantly affected and earnings will fall for a given quality of labor. The quantitative effect of the former qualification can be estimated through unemployment data, but the latter is so difficult to measure that no one has done so to date.

Figure IV-1

Illustration of Cost and Benefits of Education



OCEG = Lifetime earnings with some base amount of education

OKLF = Earnings while educating (part-time employment, scholarships, etc.)

KCDL = Foregone earnings while educating

FABG = Earnings stream after additional education

OHIF = Direct costs of additional education.

Note: There is no negative sign attached to the region below time axis.

education before taking up a full-time job, his lifetime financial pattern consists of the two following stages. In the first stage, when he is at school, he undergoes the direct costs of education (area OHIF) and earns some income (area OKLF). This income, which is resulted from part-time work and/or scholarships, etc. is presumably less than the potential income he could have earned had he worked full time (area OCDF). The difference between these two potential and actual earnings (area KCDL) is called foregone earnings.

In the second stage of his financial pattern, the more-educated individual is assumed to have an earning stream such as the area FABG. This area, which shows earnings of the more-educated individual until the end of his earning period, is presumably wider than the area which illustrates his earnings during the same period if he had not obtained that additional amount of education (area FDEG). The difference between these two areas, i.e., area DABE is the earnings differential due to education.

In the final analysis, the earnings differential due to education is supposed to be more than the total costs of education, i.e. DABE $>$ OHIF + KCDL, otherwise, education does not seem to be economical.

Social Costs and Benefits of Education: All of the private costs and benefits of education are also social costs and benefits, as society encompasses all individuals. In addition, there are costs and benefits which are realized by society as a whole.[1] These include respectively a major part of the resource costs of education,[2] and certain external benefits[3] such as technological progress, increases in knowledge, the reduction of delinquency, the promotion of democracy and the attenuation of prejudices. Because the benefits of externalities are so complex and difficult to quantify, it is not easy to bring them explicitly into the determination of the benefits of education.

However, neither the social nor the private side of the decision regarding the quantity of resources devoted to education is generally made within an explicit cost-benefit

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[1] Although these could be included in the discussion of the private costs and benefits as the individual's share of the total, it is easier to discuss them separately.

[2] Factors such as labor, capital and land are used in the educational process.

[3] The entire increase in productivity attributable to education accrues to the society if there is no net out-migration of educated people.

framework. This is partially because of past and even present lack of knowledge about the economic benefits of education and an appropriate way to analyze them.

Nevertheless, the cost-benefit approach is widely used both for the individual and social concerns about education. In order to evaluate the accuracy of this approach we will examine the ways in which costs and benefits of education are determined. But, before going into that subject it seems appropriate to get some idea about the methods being used in this approach.

Cost-Benefit Methods Used in Education

The recognition of education as a major contributor to economic development is thoroughly disseminated. Nations allocate increasing shares of their taxation revenues to the field of education in order to further stimulate economic expansion. Concurrently, much attention is turned to the task of ensuring that the scarce resources available for the educational needs be utilized as efficiently as possible. In order to cope with this acute problem of resource allocation "cost-benefit" approach in education is evolved.

In this section, first, various methods of cost-benefit approach which are usually used in educational planning, will be presented, and then, we will pay more attention to studying the methods of calculating the costs and benefits of education. This will be followed by a critical analysis of cost-benefit approach in education.

a. Net Present Value (NPV): Net present value is the present value of total benefits attributable to the investment minus the total cost of investment, both discounted at an appropriate rate to a common year. This is given by the following formula:

$$NPV_a = \sum_{K=g+1}^{T} \frac{B_K}{(1+r)^{K-g}} - \sum_{t=a}^{g} \frac{C_t}{(1+r)^{t-a}}$$

where:

NPV_a = discounted net present value of the investment in education for a student who enters the program at age a.

a = age at which the student enters the educational program

C_t = cost of education at age t

B_K = adjusted earning differential in age K attributable to education

g = student's age on graduation from the education system

r = discount rate

T = terminal earnings age.

b. Internal Rate of Return: The internal rate of return is the discount rate which makes the present value of the total benefits equal to the present value of the total costs and is computed by the formula shown for the net present value when $NPV_a = 0$ as follows:

$$NPV_a = \sum_{K=g+1}^{T} \frac{B_K}{(1+r)^{K-g}} - \sum_{t=a}^{g} \frac{C_t}{(1+r)^{t-a}} = 0$$

or

$$\sum_{K=g+1}^{T} \frac{B_k}{(1+r)^{k-g}} = \sum_{t=a}^{g} \frac{C_t}{(1+r)^{t-a}}$$

where, again, all symbols have the same definition as above except for r which is determined endogenously here as the internal rate of return.

Internal rate of return could be estimated for private or public returns from investment in education. The former is called private rate-of-return and the latter social rate-of-return. Accordingly, the decision criterion in each case could be mentioned as follows:

1) For individual: continue education if the private rate of return on the next increment of education exceeds the yields of the best alternative investment option, and not otherwise.

2) For society: invest in education until the marginal social rate of return of education falls to equality with the social discount rate.[1]

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[1]The appropriate social discount rate has been a contentious issue in studies of public investments. However, any rate between 4 and 10 per cent has been rationalized and no case has been much more convincing than any other. For example, Marglin tends to take as social discount rate, the rate of social time preferences, provided the costs of education are measured to allow for their social opportunity cost. This formulation seems somewhat arbitrary if we consider the rate of social time preference as independent of the investment decision, but as Feldstein argues, this may not be serious, at least with reference to investment in one small sector. See Steve A. Marglin, "The Social Rate of Discount and the Optimal Rate of Investment," Quarterly Journal of Economics (February 1963A); and "The Opportunity Costs of Public Investment," Quarterly Journal of Economics (May 1963 B). Also, M. S. Feldstein, "The Social Time Preference Rate in Cost Benefit Analysis," Economic Journal (June 1964).

The net present value and rates of return methods are commonly applied techniques in cost-benefit approach to education. Also, there is another method derived from net present value called benefit/cost ratio. In this method the present values of benefits and costs of education are compared. The decision criteria is that: invest in education if the ratio is greater than 1.

Estimation of Humanpower Requirement Through Cost-Benefit Approach

As was mentioned already, the decision criterion in society with regard to investment in education was to increase the number of educated people until the marginal social rate of return of education (r_s) equates the social discount rate ($\bar{r}_s$) i.e.:

$$r_s = \bar{r}_s \quad (1)$$

Ignoring the psychic benefits and external economies attached to the education, one can consider the societies gain in production differentials due to education as the only return to the society. Assuming wages measure the marginal product, we can write:

$$R = W_M - W_L \quad (2)$$

where: R = Return due to education

W_M = Wages paid to more-educated

W_L = Wages paid to less-educated

Also, considering the loss of student's production (W_L)

and direct costs of education as (T) and disregard any other costs involved, we have:

$$C = W_L + T \tag{3}$$

where:

C = total cost of education

T = tuition and other direct costs of education if all costs are treated as incurred in one year; hence:

$$r_s = \frac{W_M - W_L}{W_L + T} \tag{4}$$

where:

r_s = cross-sectional marginal social rate of return on education.[1]

r_s (as above) is the government's target variable. The aim is to maintain equation (1), i.e. $\bar{r}_s = r_s$. The instrument variable is the number of graduates which the government can regulate. The relation between target and instrument comes through the demand for education. Assuming this depends on the relative wages and time, then:

$$g = g_1 \left(W_M / W_L, t \right) \tag{5}$$

since: $r_s = (W_M - W_L)\ (W_L + T)$ (1)

therefore: $g = g_2 \left(r_s, W_L, T, t \right)$ (6)

Assuming W_L and T as depending on time, we have:

$$g = g_3 \left(r_s, t \right) \tag{7}$$

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[1]This rate is marginal since the wages (returns) reflect marginal products by assumption.

and hence, the desired equilibrium stock of graduates is:

$$\bar{g} = g_3\ (\bar{r}_s,\ t) \qquad (8)$$

$\bar{g}$ shows the nation's humanpower requirement as an optimal number drawn from a set of possible numbers and it changes over time in response to shifts in demand.[1]

This general framework, provides us with the predictability of rate of return method under a number of simplifying assumptions. In addition to questions such as: how much could be learnt for policy purposes from studying the cross-sectional rate of return? and how significant is the forecasting of shifts in demand for education? The method of achieving the desired stock are still questionable.

Comments.

Considering education as an investment, it seems plausible to apply the cost-benefit approach in evaluating its process. However, the question is not as simple. There are numbers of questions involved about the application of this approach:

- How are costs and benefits of education determined?
- Which rate should be considered as the discount rate?
- How sensitive the results are to the changes of this rate?

These are some, among many questions which come to

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[1]For a different framework, see M. Blaug, "Approaches to Educational Planning," Economic Journal (June 1967), pp. 285-6.

mind about the practicality of the cost-benefit approach, in addition to the questionability of its theoretical foundations.

Since a full description of these points might put us off the main line of the present work, what follow are brief discussions of the main objections to this approach.

a. Empirical Objections: The empirical objection to cost-benefit approach in education could be categorized under three headings: flaws in estimation of costs; flaws in estimation of benefits and flaws in the choice of discount rate.

i) The cost of education for individuals could be generally shown as:

cost to individual = foregone earnings + fees-grants

but ~~how the~~ components of costs are determined is very important. For example, in the case of foregone earnings, no data exists and hence some arbitrary approximation is usually made. The estimation of fees is not usually problematic. But, for the individual student, the consideration of the total cost as above is erratic if the education involves some psychic benefits as well. In such a case either the psychic benefits should be included in the benefits of education or the cost of education should be deducted for this amount which is consumption in nature rather than investment. The estimation of cost of education for the society have the same difficulties although the cost is slightly different as below:

Cost to society = Loss of student's production
+ Cost of tuition

ii) The benefits or returns of education both to individual as well as society could be shown generally as:

Returns to individual = Earnings differential (post tax)
+ Psychic benefits

Returns to society = Differential gains in production
+ Psychic benefits
+ Net external economies

In order to measure earning differentials, wages of more-educated and less-educated individuals are compared. This is not a valid approximation because:

- marginal productivity theory and hence considering the wage of marginal workers for measurement of earning differentials is invalid. As Sen has pointed, "there is no indication of what change would occur if a substantial increase were contemplated."[1] In addition, differences in wages do not adequately measure the differences in productivity of workers because of labor market imperfections.

- Also earning differentials usually reflect other aspects in addition to education including natural ability, social background, occupation, sex, motivation, non-formal education, etc. Therefore, attributing the earning

[1] A. K. Sen, "Models of Educational Planning and Their Application," <u>Journal of Development Planning</u>, No. 2 (New York: UN, 1970), p. 6.

differentials to formal education is a mistake.

Besides earning differentials or direct benefits, education generates indirect gains or what we have called psychic benefits and external economies. The psychic benefits are mostly the prestige and other psychic gains attached to education for individuals and the externalities are spillover benefits of education to the society. However, quantification of these gains is very difficult and there is no commonly agreed upon way.

iii) The choice of an appropriate discount rate is also a problem in cost-benefit analysis of education both for individuals as well as society. The market rate of interest is a rate generally used to discount the costs and benefits of education especially for individual graduates. This rate might be valid as long as we assume perfect competition in both factor and capital markets. Otherwise market interest rates could not be a good proxy.[1]

b. Theoretical Objections: The theoretical objections to cost-benefit approach into education, as in any other type of approach, are directed towards its underlying assumptions as follows:

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[1]In a similar ground, Mincer has proved that: "If the competitive assumptions are relaxed, internal rates of return cannot be equated with the market rate of interest and generally differ among individuals." See Jacob Mincer, "The Distribution of Labor Incomes: A Survey," Journal of Economic Literature, 8(1), (March 1970), p. 7.

1. Education is an investment.

2. Students acquire more education for earning purposes and society invests in education for production purposes.

3. Students are well-informed about the career prospects and society is certain about the skilled requirement.

4. Educated people are fully employed immediately after graduation.

5. Elasticity of substitution between skilled labor is infinite.

These assumptions are exactly opposite to the underlying assumptions in fixed coefficient models.[1] While the world characterized by fixed coefficient models is a Leontief stereotype universe with extreme complementarities in both markets of education and labor, the world characterized by cost-benefit models is a sort of neo-classical universe with substitutabilities in both education system and production process.

Evidently, none of these two extremes represent the real world, a world which lies somewhere in between. Therefore, the responsibility of planning requires to look for other models which could approximate the real life.

5. Occupational-Educational Models

The models that we are going to present in this section are, in general, along the line of a new international movement in applying a reformed approach to strategic

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[1]For more insight, see Maureen Woodhall, Cost-Benefit Analysis in Educational Planning (Paris: Nesco, 1970).

humanpower planning. In this type of approach, starting with the projections of output and productivity and deciding upon an appropriate production function, the following stages are conducted:[1]

a) occupational structure of economic sectors
b) educational structure of occupations
c) educational structure of economic sectors

The first two stages, i.e., occupational structures of economic sectors and educational structures of occupations, could be projected by any of the following methods:[2]

i) extrapolation of past trends
ii) international comparisons
iii) interfirm comparisons

After projecting the first two stages, determination of the third stage follows automatically. Obviously, in the absence of a sufficiently long and correct time-series data for the occupational structures of economic sectors and educational structures of occupations and the lack of appropriately detailed data about the quantity and quality of the workers in individual firms, the only guide to connect the

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[1]The conduction of these stages could be made either through a series of successive approximations or by applying a simultaneous solution. Whereas the successive approximation method can explore the possible alternatives (partial substitution possibilities), the simultaneous solution procedure assumes that to each sector of final demand corresponds a unique occupational educational structure. This point is elaborated later on in this chapter.

[2]See L. Emmering and H. Thias, "Projecting Manpower Requirements by Occupations," in <u>Lectures and Methodological Essays on Educational Planning</u>, (Paris: O.E.C.D., 1966).

link between economic growth and different types of human-power is 'international comparison'. This procedure is followed so far, by a number of organizations and individuals as follows:

1) M. A. Horowitz, M. Zymelman and I. L. Herrnstadt, Manpower Requirements for Planning: An International Comparison Approach, Northeastern University, Boston, December 1966 (2 volumes).

2) P. R. G. Layard and J. C. Saigal, "Educational and Occupational Characteristics of Manpower: An International Comparison," British Journal of Industrial Relations, Vol. IV, July 1966.

3) N. E. I., The Educational Structure of the Labour Force: A Statistical Analysis, Netherlands Economic Institute, Rotterdam, March 1966 (mimeogr. pub. No. 37/66).

4) J. C. Scoville, The Occupational Structure of Employment, 1960-1980, I. L. O., Geneva, August 1966 (mimeographed).

5) O.E.C.D., Occupational and Educational Structures of the Labour Force and Levels of Economic Development, "Possibilities and Limitations of an International Comparison Approach" (Paris 1970) and "Further Analysis and Statistical Data" (Paris 1971).[1]

Production Function

A good starting point to compare the above mentioned works could be by looking at their underlying production functions. This could be done by building up a general form of production function to be applied in different approaches.

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[1]For the sake of simplicity the five approaches cited here will be referred to respectively as 'Horowitz', 'Layard', 'N. E. I.', 'Scoville' and 'O.E.C.D.'.

The general format of production function according to which output (Q) is a function (F) of capital (K) and labor (L) is helpful in this regard.[1]

$$Q = F(K,L) \qquad (1)$$

This function implies that (i) K and L are homogeneous factors and (ii) that there is no effect from any other factor besides K and L. Therefore, if there exist other factors such as "technical progress" (e), it could be taken into account as:

$$Q = F(K,L,e) \qquad (2)$$

Moreover, if L is not a homogeneous factor, as heterogeneity arises by occupation categories,[2] then it seems reasonable to distinguish between them in the production function:

$$Q = F(K, L_1, L_2, \ldots L_n) \qquad (3)$$

where L_k is labor with occupation k (k=1, ... n).

Now if we assume constant returns to scale (CRS) the function (3) could also be written as:

$$Q/L = F(K/L, L_1/L, L_2/L, \ldots L_n/L) \qquad (3a)$$

Furthermore, if within any occupation different educational qualifications are required then the production function

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[1] 'F' stands for the term 'function' throughout this work and does not imply necessarily the 'same function' everywhere.

[2] By definition each occupation requires specific skills and training.

will take the following form:

$$Q = F\,[K,\ L_1(E_i),\ L_2(E_i),\ \ldots\ L_n(E_i)]\quad i = 1,2,\ \ldots\ m \qquad (4)$$

where $L_k(E_i)$ stands for E_i levels of educational attainment reached by the members of the occupational category L_k. In case, if we are not interested in classification of labor force according to occupations, equation (4) could be simplified by dividing the labor force L into the educational categories (L_i's):

$$Q = F\,[K,\ E_1,\ E_2,\ \ldots\ L_m] \qquad (5)$$

where clearly[2] $\sum_{i=1}^{m} E_i = L$

However, none of the works under review has adopted exactly any of the forms we depicted for production function simply by assuming away the capital (K). This is the common feature of these models. Nevertheless, they are not totally comparable, and sometimes they are opposite to each other.

Horowitz, by assuming K/L as a function of occupational distribution of L, adopts:[3]

$$Q/L = F(L_1/L,\ L_2/L,\ \ldots\ L_n/L) \qquad (6)$$

where $\sum_{k=1}^{n} L_k = L$.

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[1]By definition each occupation requires specific skills and training.

[2]Note that the classification of labor force (L) here is on the basis of educational levels (i=1,--m) rather than occupational categories (k=1--n).

[3]This naive assumption is hard to justify. See Horowitz, p. 32; also O.E.C.D., p. 30.

Function (6) implies that (i) for a given level of average labor productivity (Q/L), the capital output ratio (K/L) is fixed; (ii) there are substitution possibilities between various occupations.

Layard on the other hand takes a reverse view by postulating the dependence of occupational composition of humanpower on the average labor productivity as follows:[1]

$$L_k/L = F(Q/L) \qquad (k=1 \text{ --- } n) \qquad (7)$$

Equation (7) implies that the percentage of labor in any occupation k is determined by the average productivity of labor in the whole economy. Therefore, it could be interpreted that this type of equation is a disaggregated version of N. E. I.'s demand type of equations we considered earlier.[2]

With regard to substitution, both Horowitz and Layard agree to the general substitutability before the choice of technique. After that, according to Layard, there is no possibility for any type of substitution (general complementarity), but, according to Horowitz, even then there exist possibilities for substitution between various occupational categories (partial substitutability).

The production function of the other three studies are similar to Layard's form with other types of explanatory

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[1]Layard, p. 225.

[2]See N. E. I.'s Naive Demand Model.

variables:[1]

In N.E.I. approach: $L_i/N = F(Q/N) \quad i=1 \text{ --- } m \quad (8)$

where: L_i refers to educational categories

N = population

in Scoville: $L_k/L = F(Q/N,G,N) \quad K=1 \text{ --- } n \quad (9)$

where: G = growth rate of national income

L = total labor force

and in O.E.C.D. $L_k/L = F(X) \quad K=1 \text{ --- } n \quad (10)$

where, according to O.E.C.D.,: "X stands for any of the explanatory variables selected to reflect levels of economic and technological development."[2]

First Stage: Occupational Structure

Except for N.E.I., the other four studies have examined a relationship between occupational structure of humanpower and their favorite explanatory variable.

Horowitz, as a pioneer, has tested equation (6) by distinguishing five major occupations (K=1, ... 5) and hence:

$$Q/L = F(L_1/L,\ L_2/L,\ L_3/L,\ L_4/L,\ L_5/L) \quad (11)$$

where: L_1 = professional and technical workers

L_2 = administrators and managers

L_3 = clerical workers

L_4 = sales workers

L_5 = manual workers

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[1]The choice of explanatory variables has been theoretically discussed in N.E.I. study, pp. 23-27.

[2]O.E.C.D., pp. 39-40. Note that in the original report the variable X is shown as n.

Using cross-sectional data over 26 countries, this equation is tested for 21 branches of manufacturing as well as for manufacturing as a whole. The conclusion he has come to is: "the productivity of an industry is linked to a specific occupational distribution of its labor force."[1]

Layard, on the other hand, has applied a form of equation (7) to test the relationship between sectoral productivity of labor and occupational structure of the labor force as:[2]

$$L_{jk}/L_j = F(Q_j/L_j) \quad (12)$$

where j=1 ... t refers to sectors of the economy.[3] In addition to a slightly different classification of occupations and different samples of observations,[4] Layard's equation, as was mentioned already, is almost the exact reverse of Horowitz's equation. Moreover, it examines sectors of the

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[1]Horowitz, p. 32.

[2]Layard has classified occupations as:
a) professional and technical
b) administrative and managerial
c) clerical workers
d) sales workers
In addition, he has tested his equation for some combinations of these four.

[3]Layard's analysis was carried out in the eight economic sectors where he noticed "that the sectors with poorer relationships are also on the whole the smaller sectors." Layard, p. 242.

[4]The maximum number of observations in Layard's study of occupational structures of labor force is 20 (out of more than 30 countries under study).

economy rather than industries.

As a general interpretation of the results of Layard's study, it is permissible to infer that his approach is much more prudent than Horowitz's in so far as he emphasizes the necessity of further research.

Scoville has undertaken equation (9), similar to Layard, with the aim of projecting the distribution of employment among jobs of varying levels of social and economic status.

In the other studies, N.E.I., being mainly concerned about educational structure, has not examined the occupational structure of the labor force. But O.E.C.D., by applying equation (10), a demand-type equation similar to both Layard's and Scoville's, has examined the occupational percentage distribution as well as the analysis of different values observed in the occupational coefficients, namely L_k/N instead of L_k/L.

<u>Second Stage: Educational Structures of Occupations</u>

This approach is undertaken by three of the five studies under review.

Layard has pioneered such a study by applying two types of equations:

$$L_{ik}/L_k = F(Q/L) \qquad (13)$$

$$M_k = F(Q/L) \qquad (14)$$

where: $i = 1, 2, \ldots 5$ educational category[1]

$k = 1, \ldots 4$ occupation

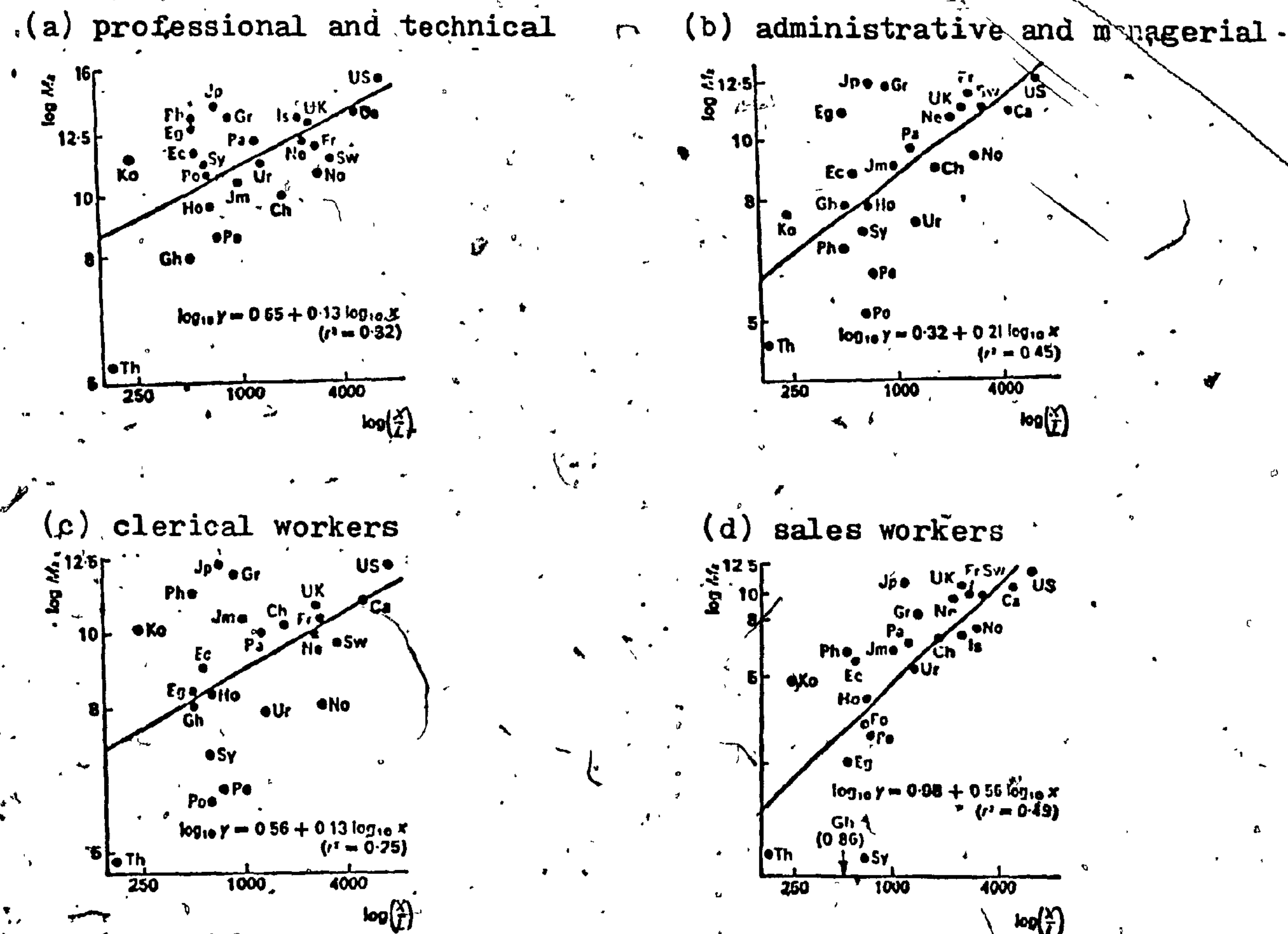
M = Mean (or median) years of education

The number of observations in this study ranges from 14 to 24 (depending upon the educational category) with the general conclusion that there exists a tendency for educational levels of occupations to rise with output per worker (average labor productivity). Although the causality of such movement is not mentioned explicitly, it could be interpreted that it might imply the effect of quality improvement of humanpower on the expansion of output. However, examining Layard's results, we find this pattern to be rather indistinct for all occupations except for sales workers where it is well defined at each educational level. This is the case specially for mean years of schooling (equation 14) as is depicted in the following figure (IV-3).

[1]The educational categories distinguished in Layard's study are: (i) degree level; (ii) completed secondary schooling; (iii) matriculation level; (iv) completed middle level schooling; (v) completed schooling.

Figure IV-2

Mean Years of Schooling of Specified Occupation Groups



Key to country abbreviations: Argentina (Ar), Canada (Ca), Chile (Ch), Costa Rica (Co), Ecuador (Ec), Egypt (U.A.R.) (Eg), Finland (Fi), France (Fr.), Korea (Republic of) (Ko), Mexico (Me), Netherlands (Ne), Norway (No), Panama (Pa), Peru (Pe), Philippines (Ph), Portugal (Po).

Source: Layard, p. 257.

Notes: (1) The corresponding equations that are fitted in log-linear form for equation 14 are of the form $M_k = a_1 (\frac{Q}{L})^{b_1}$ where the constants (a_1 and b_1) are estimated.

(2) The y and X in the reported regression equations refer to the corresponding ordinate and abscissa realms (output in U.S. $).

(3) All graphs are on double log scale. Y-scale for occupations a-c is double that for occupations d.

According to figure IV-3, the average education of professional and technical workers is higher than other occupational categories in all countries under study and that of sales workers is in all cases lower than that of all other occupations.

In O.E.C.D., some analogous approaches are made by testing the following general types of relationship:

$$L_{ik}/L_k = F(X) \tag{15}$$

$$L_{ik}/L = F(X) \tag{16}$$

Equation (15) follows the so-called humanpower approach, which forecasts occupational structure and converts each of the occupational categories into educational equivalents. Equation (16) which could be considered as a weighted occupational category will provide us with the same information as equation (15). The rational for its building is stated as to: "serve to test the hypothesis that when only certain educational categories within the occupational groups are taken into account, measurement errors will tend to diminish and the change of obtaining better relationships will consequently improve."[1]

In addition to testing equations (15) and (16) which are demand type of equations, a further significant step is taken by O.E.C.D. for examining the effects of the supply side of education by applying the following equations:

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[1]O.E.C.D., p. 40.

$$L_{ik}/L_k \text{ or } L_{ik}/L = F(L_i/L) \text{ or } F(X, L_i/L) \quad (17)$$

The purpose of this examination is stated as:

> Next to the above types of "demand" equations, an attempt will also be made to examine whether the educational supply pattern can, to any extent, add to the explanation of the observed differences in educational profiles of the occupational categories. This is done by introducing the total stock of people in the labour force with a level education (i) which normally corresponds to the occupational category in question. This variable (L_i/L) will be examined alone and in combination with the economic and technological indicators (x).[1]

Third Stage: Educational Structures of Economic Sectors

The analysis of educational profile of other sectors of the economy is made only by Layard and O.E.C.D. Using the same occupational categories and educational groupings as mentioned earlier, the following type of equations are adopted:

$$L_{ij}/L_j = F(Q_j/L_j) \quad (18)$$

$$M_j = F(Q_j/L_j) \quad (19)$$

Hence: L_{ij} = number of individuals with educational level i in sector j

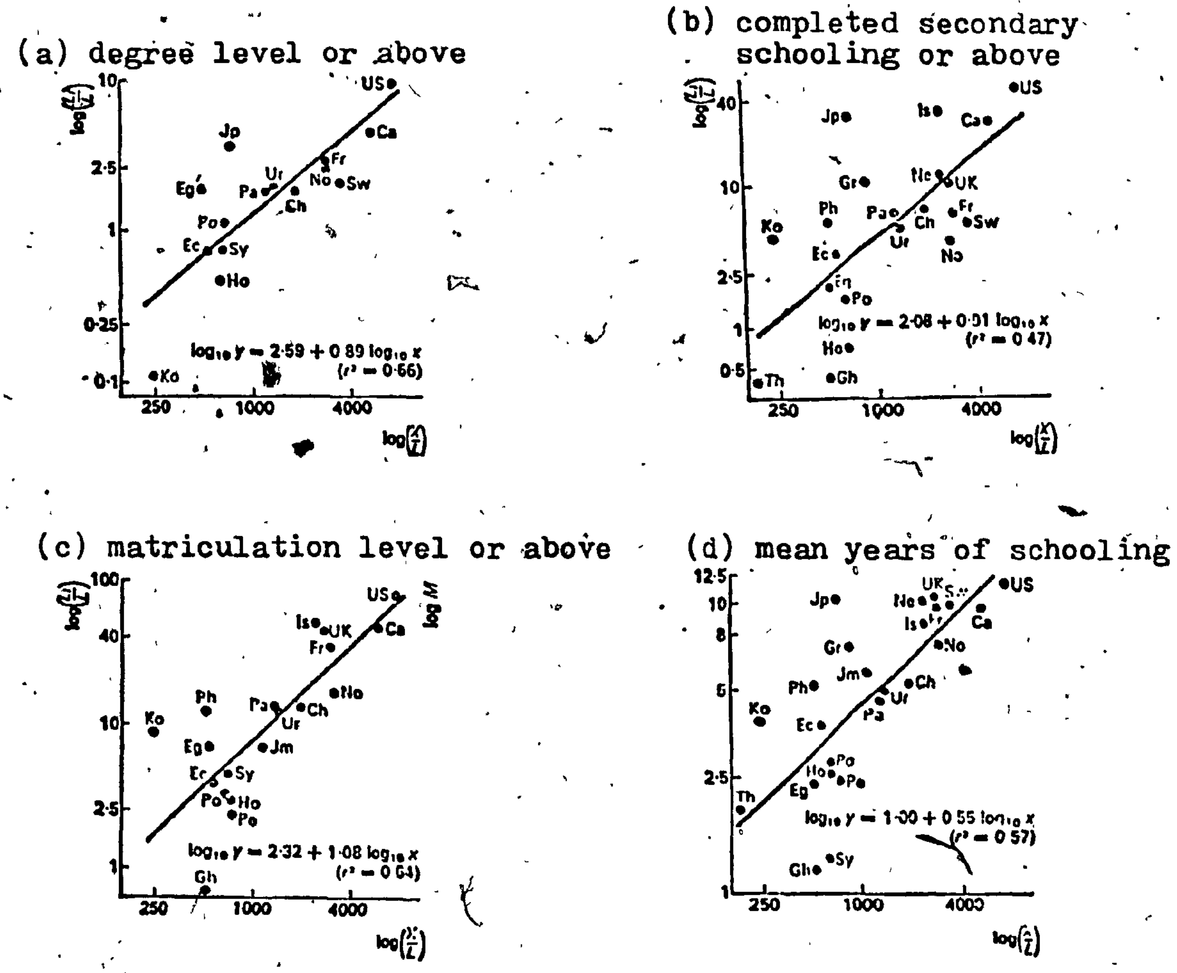
M_j = the mean (or median) years of formal schooling embodied in sector.

A similar form of equation is applied to the economy as a whole by Layard which result is depicted in the following figure (IV-4).

[1] O.E.C.D., p. 40.

Figure IV-3

EDUCATIONAL LEVELS; THE WHOLE ECONOMY



Key to country abbreviations: Ghana (Gh), Greece (Gr), Honduras (Ho), India (In), Israel (Is), Jamaica (Jm), Japan (Jp), Sweden (Sw), Syria (Sy), Thailand (Th), Turkey (Tu), United Kingdom (UK), United States (US), Uruguay (Ur).

Source: Layard, p. 258.

Notes: (1) The corresponding equations that are fitted in log-linear form for the first three panels could be shown as $\left(\frac{Li}{L}\right) = a_2 \left(\frac{Q}{L}\right)^{b_2}$ and the one for the fourth panel as $M = a_3 \left(\frac{Q}{L}\right)^{b_3}$ where the constants (a's and b's) are estimated.

(2) The y and x in the reported regression equations refer to the corresponding ordinate and abscissa values (output in U.S. $).

(3) All graphs are on double log scale.

The first three panels of figure IV-4 refer to educational levels while the fourth panel is based on the mean years of schooling. In other words, Layard's analysis is carried out in terms of two different measures: percentage of workers with more than a particular level of education and average years of schooling. As it is apparent from figure IV-4, these two ways of measuring the educational attainments provide us with different results. This is so not only for the economy as a whole but also for various occupations. For example, in the case of occupations, in sales the corresponding equations are estimated as:

$$\frac{L_{ik}}{L_k} = 0.0015 \left(\frac{Q}{L}\right)^{1.09} \qquad (R^2 = 0.30)$$

$$M_k = 0.105 \left(\frac{Q}{L}\right)^{0.56} \qquad (R^2 = 0.49)$$

Therefore, it could be inferred that there should have existed a great deal of unexplained variance in the output of educated workers within and between occupations and sectors across different countries, so that makes such an approach of limited value.

Comments

The approaches reviewed in this section had some unique characteristics as well as some common ones.

Horowitz's work has its credit mainly because of pioneering in initiation of this type of approach. In his study, the correlation coefficient (R^2) ranges from 0.306 -

(for electrical machinery) to 0.880 (for lumber and wood products) and there is no industry with all the regression coefficients significant at 95% confidence level.[1]

Layard's study, comprehensive enough by considering all three stages of approach as mentioned earlier, provides more satisfactory results. In the first stage of approach, relationships between occupational structure and productivity at the economy level, the correlation coefficient (R^2) range from 0.25 (for sales workers) to the maximum 0.83 (for professional and technical). Comparing the R^2's gained at the economy level with the R^2 for sectoral relationships, the former's are higher than the latter's. This accords with the normal expectations for stronger relationship within sectors than for the economy as a whole.[2] Layard's second stage of approach (educational structure of occupations) confirms the relationship between the change in education with the change in productivity in a better way for mean years of schooling than otherwise. With regard to the third stage, the results are very unimpressive. As Blaug has pointed out: "If the sectors are ranked according to the

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[1] In most of the cases, only two occupations yielded significant coefficients and the other three occupations (according to his classification of occupations) are dropped. See Horowitz, Vol. 1, Tables 3 and 4.

[2] Since $R^2 = 1 - \frac{\sigma_e^2}{v}$ where σ_e stands for the standard deviation and v for the variance. At the sectoral level we expect, normally, a lower variance and hence a smaller R^2 relative to the economy as a whole.

amount of variance 'explained', the first are commerce and agriculture followed by manufacturing -- the same three as with the regressions for occupational structure."[1]

In the O.E.C.D.'s approach, it is attempted to avoid the objections made to the previous approaches by running the estimating equations on a much larger body of data,[2] as well as re-running more equations through applying more explanatory variables.[3] Moreover, recognition of supply factors, even though not satisfactorily handled, is another step taken in O.E.C.D. approach. However, despite these efforts, the results of this approach suffer more or less from the same weakness as of its predecessors. The major problems encountered in all of these approaches are as follows:

a) The problem of <u>data limitation</u> imposed due to the number of observations and their reliability. This is more or less a general problem to all of the studies (less so for O.E.C.D.'s).

b) The problem of <u>disaggregation</u> at all three stages of analysis, i.e., sectoral, occupational and educational structures. Whether the assumed classifications within each

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[1]Blaug, p. 80.

[2]O.E.C.D.'s sample consists of eight one-digit economic sectors, ten two-digit occupations and four levels of education for fifty-three countries.

[3]This is also the case in Scoville's study but in a very limited extent and less rationalization.

structure is the best representative one, and if so, whether a unique pattern of classification of each structure is equally applicable to various countries under study, are not clearly confirmed.

c) The choice of explanatory variable to reflect the economic and technological development is somehow ad-hoc. All studies have adopted total or sectoral labor productivity (except Scoville and O.E.C.D. which have examined other variables as well) more or less on an arbitrary basis. Although the resultant estimating coefficients are significant in some cases, still it should be wondered whether a statistically acceptable relationship could confirm its existence in the real world. Except for Layard and O.E.C.D. which have thought of this discrepancy, others have drawn general conclusions from every non-responsive relationship.

d) A major drawback of these studies is the application of regression analysis on the basis of cross-sectional data. There is a great deal of controversy about the validity of cross-sectional estimates especially for international comparisons.[1] The main reason in this regard is the

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[1] The well-known article by H. B. Chenery, "Patterns of Industrial Growth," *American Economic Review*, (September 1960), for example, is based on cross-section evidence. The parameters determined in this way have been much criticized when compared with time-series evidence; see M. D. Steuer and C. Voivodas, "Import Substitution and Chenery's 'Patterns of Industrial Growth'," *Economie internationale*, (February 1965). Many other examples can be found in Murray Brown (ed.) *The Theory and Empirical Analysis of Production*, (New York: 1967), p. 8.

inconsistency of data for different countries mainly due to different methods of data collecting and different definitions for the similar items. This is so both from quantity and quality points of view. For instance, the same educational levels require different years of schooling as well as different educational attainments in different countries. Therefore, treating these heterogeneous entries similarly as is the case in cross-sectional analysis, is not free from error.

e) Another conceivable objection is disregarding the <u>substitution possibilities</u>. Except in Horowitz's approach which allows for some partial substitution, as was mentioned earlier, it is interesting to note that none of the other studies reviewed have attempted to raise the question of whether the same amount of output could be produced with different skill mixes <u>ceteris paribus</u>; whereas there are evidences that the composition of the labor force in any economic sector will change due to some exogenous factors,[1] ignoring this behaviour will degrade the approach.

f) Finally, we can think of the pitfall most of human-power and educational planning models are suffering from,

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[1]Some very likely substitutions are mentioned as: a) the substitution of the skill in question for other more expensive skills, or b) the substitution of human skills of all kinds for capital equipment, or c) a change in the product mix in the direction of goods using more of the cheaper skill, or when all these changes are precluded and d) an increase in the volume of output.

namely, the so-called specification problem. The evolution of occupational and educational composition of the labor force is the outcome of the interaction of demand and supply factors. Evidently the supply situation of the labor force is one of the best-attested elements in determining the level of employment. It is surprising to note that out of the studies reviewed in this chapter, only N.E.I. and O.E.C.D. have considered this simultaneity. In the N.E.I.'s approach, the single requirement equation is claimed to be the reduced form of a set of demand and supply equations.[1] If this is the case, the identification problem will arise.[2] In order to avoid such a problem, O.E.C.D. has intended to contrast the pull effects (demand side) with the push effects (supply side) by applying a set of equations (17 above). But we cannot give credit to this attempt more than what they have claimed for as O.E.C.D. Writers confess that:

> Quite clearly, these are also *ad hoc* relationships but, faced with an admitted inability up to now to derive from the theory an adequate specification of the set of structural equations, all one can do in the process of the analysis is to ask the question: is the proposed relationship a demand function, a supply function, a reduced form, or a mixture of all those?[3]

All in all, the approaches reviewed here could be

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[1]See our balanced-growth model for the case of Iran in Chapter V.

[2]The identification problem arises when it is not possible to recuperate the coefficient of the structural equation from the coefficients of the reduced form.

[3]O.E.C.D., p. 42.

considered as a significant step in furthering the humanpower and educational planning. However, in addition to their other drawbacks, they seem to assume a unique world humanpower growth path as if all the countries under study are enjoying the same economic and humanpower growth rates as well as the same pattern of sectoral, occupational and educational structures. Needless to say, this is a very rough approximation to the reality. Nevertheless, as already mentioned, to approximate the reality we must assume reality to be simpler than it in fact is. However, we should notice that those simplifying assumptions do not put us on a wrong track altogether. This needs more effort by individual researchers.

SUMMARY IV

In the course of economic development, there seems to be a growing tendency towards humanpower planning. In order to have the various kinds of qualified labor available at the right time and in the right number to assure development of the economy, having a strategic humanpower plan is inevitable. The essential problem is thereafter how to gear the qualifications of humanpower to the requirements of society.

Fortunately, in handling the problem, some approaches have been made which we exposed the evolution of them by reviewing the major planning models in this regard as: Harbison's Rule-of-Thumb, N.E.I.'s Naive Demand Model, Tinbergen's Balanced Growth Model, Cost-Benefit Analysis and Occupational-Educational Models.

In evaluating these models, their theoretical foundation as well as applicability of them were analyzed thoroughly. However, to have a better idea about them, it is possible to classify all the models reviewed under three headings:

(1) Fixed-Coefficient (F. C.)

(2) Cost-Benefit (C-B)

(3) Occupational-Educational (O-E)

We had occasion to specify the characteristics of these models and their major drawbacks. Fixed coefficient models, though commonly applied for humanpower forecasting, have been severely criticized. Their main flaws have been cited as "(i) non-substitutability between various types of humanpowers (with different skills), and (ii) the absence of labor supply behaviour. Due to their weaknesses, according to Freeman, these models could be best interpreted as "a tool for analyzing 'shifts' in demand schedules in the context of a simple supply-demand model, rather than as a device for forecasting manpower 'needs' or employment."[1]

The second sort of strategic humanpower planning models we discussed in this chapter, based on the Cost-Benefit analysis, have been applied to both MDC's and LDC's economies. As was explained in the text, the C-B approach consists of estimates of the present and future costs and benefits of education (and other sources of enskilling), considering benefits to be measured by the marginal products (factor price of the resources in a neo-classical model). The flaws of this approach, as is the case for most of the others, underly mainly in its assumptions. All in all, the cost-benefit approach to humanpower planning and decision making contains so many unrealistic assumptions, and insurmountable problems, that it would hardly seem worth the effort to spend much time with it. This has led planners to think of other methods which avoid these shortcomings.

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[1]R. B. Freeman, "Manpower Requirements Analysis and the Skill Composition of the U. S. Work Force," Harvard Institute of Economic Research, Discussion paper No. 355 (April 1974), p. 1.

The third type of models, i.e. occupational-educational, are the most up-to-date ones being applied at the international level. These models have been developed to satisfy the urgent need for the feasible comprehensive humanpower planning models in both more-developed and less-developed economies. Despite the efforts being made to improve these models, still, they suffer from some drawbacks. Since these models are built on the basis of relations that could be found between economic variables (such as per capita income productivity) and various aspects of humanpower, therefore, there is a serious need for reliable and timely long enough data. That is to say, with the improvement in the data situation, we should hope for such improvement in this regard.

CHAPTER V

PLANNING THE STRATEGIC GROWTH AGENTS IN IRAN

Iran, with nearly thirty years of national economic planning, started its so-called "manpower planning" after the second seven-year plan in 1955. The Manpower Development Division (M.D.D.) in Plan Organization (P.O.) prepared the first national humanpower plan to be carried out by P.O.'s Economic Bureau (E.B.) in 1960. While M.D.D. did not last long and was abolished in 1961, during its short life it implemented some important surveys which were helpful to E.B. in formulating further humanpower approaches. The E.B. established in 1958 was assigned the responsibility of drawing up the country's third development plan commencing September 1962. One of the major drawbacks concerning the implementation of the previous plans was the lack of a comprehensive program for humanpower. Referring to the people in charge of humanpower planning, the new planners charged that: "Each body operated on an ad-hoc basis, outside the framework of any predetermined plan and independently of other sectors, regardless of any relationship which existed between different educational levels."[1] E.B., even with its awareness of the

[1] Iran, Bureau of Information and Reports, Education in the Third Development Plan, (Tehran: Plan and Budget Organization of Iran, February 1968), p. 7.

importance of human resources, although assisted by foreign specialists,[1] was not successful to accomplish the task of planning. As Baldwin commented: "In Iran any kind of planning means swimming against strong currents, so that huge exertions are necessary to score a modest gain."[2]

The reorganization of plan organization and accordingly the resumption of M.D.D., with the new name of "Manpower Planning Bureau" (M.P.B.), to operate under the "Project and Plan Section" of P.O., was a significant move towards the humanpower planning.

The last organizational change in the plan organization took place in early 1973, coinciding with the start of the Fifth Development Plan. Plan organization was renamed "Plan and Budget Organization" (P.B.O.) and its structure was modified, presumably in such a way as to be more appropriate for handling the forthcoming ambitious Fifth Development Plan.

The structure of the Manpower Planning Bureau did not change significantly in this reorganization; however, it received a new name: "Bureau of Population and Manpower"

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[1]For details on the number of names of foreign specialists who came to Iran under the so-called "technical assistance," see G. B. Baldwin, "Iran's Experience with Manpower Planning: Concepts, Techniques, and Lessons" in Manpower and Education, ed. by F. Horbison and C. A. Meyers (New York: McGraw Hill, 1956), p. 141.

[2]G. B. Baldwin, p. 144.

(B.P.M.) to work within "Under-Secretary for Planning." This time the forecasting of humanpower requirements during the Fifth Development Plan made by B.P.M. used a new framework. Meanwhile, a comprehensive employment strategy mission being sent to Iran by the International Labor Office (I.L.O.) in response to the request from the government of Iran formulated, among other works, an analytical model for human resource projection which is the most comprehensive to date for Iran.

In addition, there are other agencies, both within the P.B.O. (namely the Education Division) and outside it, either governmental departments (Ministry of Labor and Social Affairs, Ministry of Education and Training, Ministry of Science and Higher Education) or university research institutes (Institute for Economic Research and Institute for Social Studies and Researches, both affiliated with Tehran University) are involved with different aspects of humanpower in Iran. However, there is no indication of their having performed any humanpower planning significantly distinguishable from that of B.P.M.

In what follows, we categorically survey the humanpower plans and programs according to their relevant period, namely for the past (Fourth Plan), and for the present (Fifth Plan).

1. Rule-of-Thumb Approach

The humanpower section of the Fourth Development Plan was based on the humanpower plan being made by M.P.B. and was revised several times. The last version of the applied framework was published in 1970 and will be briefly reviewed hereunder.[1]

Supply of Humanpower

In M.P.B.'s framework, humanpower is predicted both from supply and demand sides. The forecast of aggregate supply of active humanpower was based simply on the predicted population through considering factors such as urbanization, industrialization and the growth of education.[2] For projecting the population, in turn, the population census of 1966 was considered as the base with the growth rate being equal to the fertility rate minus mortality rate. These two rates are estimated separately for both urban and rural areas and hence population is predicted with the urban-rural breakdown. In addition to the plan organization, some other institutes and individuals have also projected the population of Iran, each under slightly different assumptions. A common

[1] Iran, Plan and Budget Organization, "Preliminary Evaluation of Manpower Planning in the Fourth Plan and Search for Employment Possibilities in the Fifth Plan" (Tehran, M.P.B., 1970).

[2] Ibid., p. 8.

objection to almost all of these projections is disregarding or mis-estimating the rates of emigration and immigration which, though not very important, play some significant role in the accuracy of the population projection.

Demand for Humanpower

The main part in every humanpower planning is the forecasting of the demand side of the humanpower. This is a difficult job to be performed by planners because there is no well established and commonly accepted way to forecast humanpower requirements of the economy. The limited number of models being presented so far range from very simple to complicated ones. Each of these models has its advantages and disadvantages.

The model being applied by M.P.B. could be considered as one of the simplest. In this model a direct relation is considered between growth of gross domestic product, growth of productivity and growth of demand for labor as follows:[1]

$$\dot{L}^D = \dot{G} - \dot{P}$$

where: $\dot{L}^D$ = growth rate of humanpower required

$\dot{G}$ = growth rate of Gross Domestic Product

$\dot{P}$ = growth rate of labor productivity

Assuming the growth of labor productivity remains

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[1]This equation is resulted from the following model: $G_t = L_t^D P_t$ where $P_t = Gt/L_t^D$ is labor productivity.

constant during the Fourth Plan,[1] the amount of labor required in the Fourth Plan is estimated, under the assumption of Ġ (at factor cost) = 11 per cent to increase from 7.870 million (in 1967) to 8.987 million by the end of the plan (1972).[2]

In the course of qualified humanpower requirement, a similar model is used. The reasoning is simply stated as the "existence of a meaningful correlation between the rate of production and the number of specialists and other qualified labor force."[3]

Upon the basis of this assumption on the demand side and a non-specified method for the supply side,[4] the supply and demand for qualified humanpower during the Fourth Plan is projected. The comparison between these two determines the need for almost all types of strategic humanpower if the assumed growth rate should be maintained. See Table V-1 for the results of these projections.

Comments

In order to evaluate the validity of the above-mentioned approach, especially in the case of qualified humanpower planning, we cannot make any comment on the supply

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[1]Iran, Bank Markazi of Iran, National Income of Iran: 1962-67 (Tehran: September 1969), Table 39, p. 60

[2]Plan and Budget Organization, p. 14. (Unit = Man-Year).

[3]Ibid., p. 15.

[4]It is only mentioned that the forecasting of the supply of qualified humanpower is made on some "optimistic bases." Plan and Budget Organization, p. 20.

Table V-1

Demand and Supply of Strategic Humanpower in the Fourth Development Plan[1] (1968-73)

(Professional, Technical and Related Occupations)

Occupation[2]	Expected Change in Demand (ΔL_S^D)	Expected Change in Supply (ΔL_S^S)	Shortage	Surplus
Physical Sciences and Related	17,772	7,507	10,759	494
Architects	335	320	15	---
Engineers, civil	1,812	1,553	259	---
Engineers, electrical	1,343	1,142	201	---
Engineers, mechanical	2,042	1,310	732	---
Engineers, metallurgical	267	83	184	---
Engineers, mining	361	100	261	---
Engineers, chemical	759	344	415	---
Engineers, industrial	459	40	419	---
Engineers, miscellaneous	3,383	115	3,268	---
Chemists, physicists, biologists, geologists	1,506	2,000	-----	494
Draughtsmen and cartographers	3,099	500	2,599	---
Surveyors	2,406	-----	2,406	---
Technicians	14,903	10,525	4,378	---
Civil engineering technicians	3,650	1,965	1,685	---
Electrical engineering technicians	3,049	2,700	349	---
Mechanical engineering technicians	3,732	2,460	1,272	---
Chemical engineering technicians	192	-----	192	---
Metallurgical engineering technicians	191	-----	191	---
Mineral engineering technicians	111	-----	111	---
Miscellaneous engineering technicians	3,978	3,400	578	---
Medical and Health Scientists and related	40,921	11,139	29,782	---

(cont'd. next page)

Occupation	Expected Change in Demand (ΔL_S^D)	Expected Change in Supply (ΔL_S^S)	Shortage	Surplus
Physicians (& Surgeons)	3,831	2,879	952	---
Dentists	1,194	450	744	---
Pharmaceutical specialists (& related)	2,570	600	1,970	---
Veterinarians	560	260	300	---
Professional nurses	2,648	1,800	848	---
Midwives	1,871	150	1,721	---
Non-professional nurses	11,693	3,100	8,593	---
Medical and health technicians	16,554	1,900	14,654	---
Social Sciences and related	25,773	6,974	19,396	597
Economists	703	1,300	------	597
Accountants	11,812	1,250	10,562	---
Statisticians and mathematicians	438	400	38	---
Anthropologists, sociologists and personnel specialists	4,859	3,295	1,564	---
Librarians and archivists	203	180	23	---
Jurists, lawyers	7,758	549	7,209	---
Artistic, writing, entertaining & related	16,197	1,842	14,355	---
Educators	98,613	?	?	?
Tertiary Educators[3]	3,312	?	?	?
Secondary Educators	19,318	1,740	17,578	---
Elementary Educators	48,610	35,000	13,610	---
Religion[4] Educators	18,632	?	?	?
Others	8,741	520	8,221	---

Notes: 1. This table is based on the M.P.B.'s estimated L^D and L^S (1970).

2. Most of the titles accord with ILO's classification of occupations. Nevertheless, comparing with ILO's detailed "Professional, Technical and Related Occupations," many are missing. Note, however, that the classification of educators is ours.

3. In the cases of tertiary and religion educators no estimation is given. This leaves the estimation of their shortages or surpluses (and hence for educators as a whole) incomplete.

side which is not explicitly specified. Thus, the demand side remains as the only part to be evaluated. This side could be best inferred to be a modified version of Harbison's rule as it maintains an unjustified relation between the growth rate of labor demanded and the growth rates of GDP and productivity of labor. Therefore, as was commented on, the Harbison's Rule-of-Thumb approach does not have a sound theoretical basis and hence is not reliable.

2. Balanced Growth Approach

A more sophisticated model applied to forecast qualified humanpower requirements in Iran is a modified version of J. Tinbergen, Correa and Bos's approach.[1] In so doing, taking 1966 as the base year, the balanced growth of the Iranian educational system is estimated for three consecutive six-year periods (1966-72, 1972-78 and 1978-84).[2]

Format of the Model

The initial format of the model being adopted for planning the humanpower requirement in Iran is the modified version of Tinbergen's Balanced Growth Model depicted earlier as:

$$N_t^2 = \nu^2 V_t \qquad (1)$$

$$N_t^2 = N_{t-1}^2 - m_{t-T^2}^2 + m_t^2 \qquad (2)$$

$$m_t^2 = \mu^{21} n_{t-1}^2 + \mu^{22} n_{t-1}^3 - n_t^3 \qquad (3)$$

$$m_t^3 = \mu^3 n_{t-1}^3 \qquad (4)$$

$$N_t^3 = N_{t-1}^3 - m_{t-T^3}^3 + m_t^3 \qquad (5)$$

$$N_t^3 = \nu^3 V_t + \pi^2 n_t^2 + \pi^3 n_t^3 \qquad (6)$$

where the variables and coefficients have the same definition

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[1] Tinbergen's Balanced Growth Model, Ch. 4, p. 74.

[2] G. H. Baher, "Planning the Manpower Requirement of Economic Development: The Case of Iran," Quarterly Journal of Economic Research, 10 (29 & 30), Spring 1973. A Persian version of this paper was also published by the Institute of Economic Research, Tehran University (1972).

as in the previous chapter.[1]

Computation of the Coefficients

In equation (1) $\nu^2 = \frac{N^2_{66}}{V_{66}} = \frac{174.3}{6840} = 0.025$ where the units for N^2 and V are one thousand students and one million dollars respectively.[2]

The time unit (t) has been assumed to be 6 years. Because the education period for secondary level at the time was 6 years in Iran, and for the sake of simplification, it is assumed that the average period for third-level education to be also equal to 6 years.

In equations (2) and(5), according to the measurements made for the productive life of humanpower in Iran,[3] these values for humanpower with a secondary and a third-level of education have been estimated 48 and 42 years respectively. Considering the unit of time equals 6 years, the values of T^2 and T^3 are respectively 8 and 7.

The size of other coefficients are also computed as

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[1]Chapter IV, pp. 75-76.

[2]The use of a time series in estimating ν^2 could be much more representative than a single year. Unfortunately, due to the lack of a series of N^2 and V, we were not able to do so.

[3]Iran, Plan and Budget Organization, Bureau of Population and Manpower.

follows:[1]

$$\mu^{21} = 0.38$$

$$\mu^{22} = 0.011$$

$$\mu^{3} = 0.87$$

$$\nu^{3} = 0.008$$

$$\pi^{2} = 0.03$$

$$\pi^{3} = 0.07$$

where the last two coefficients imply 35 and 15 students per teacher, respectively.

The model with estimated coefficients, therefore, is:

$$N_t^2 = 0.025V_t \qquad (1.a)$$

$$N_t^2 = N_{t-1}^2 - m_{t-8}^2 + m_t^2 \qquad (2.a)$$

$$m_t^2 = 0.38n_{t-1}^2 + 0.011n_{t-1}^3 - n_t^3 \qquad (3.a)$$

$$m_t^3 = 0.87n_{t-1}^3 \qquad (4.a)$$

$$N_t^3 = N_{t-1}^3 - m_{t-7}^3 + m_t^3 \qquad (5.a)$$

$$N_t^3 = 0.008V_t + 0.03n_t^2 + 0.07n_t^3 \qquad (6.a)$$

For the sake of simplification, it is assumed that the drop-outs from humanpower with the second and third-level of education, in any period, to be respectively proportional to the size of those humanpowers in the previous period. Using λ^2 and λ^3 respectively for those proportions, the following

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[1]For details of calculation, see G. H. Baher, Appendix A, p. 199.

equations (2.b) and (5.b) are adopted instead of equations (2.a) and (5.a):

$$(2.b)\quad N_t^2 = (1-\lambda^2)N_{t-1}^2 + m_t^2 \qquad (2.b)$$

$$(5.b)\quad N_t^3 = (1-\lambda^3)N_{t-1}^3 + m_t^3 \qquad (5.b)$$

in which the estimated values of λ^2 and λ^3, are:[1]

$$\lambda^2 = 0.011 \text{ and } \lambda^3 = 0.018$$

Therefore the model is:

$$N_t^2 = 0.025V_t \qquad (1.b)$$

$$N_t^2 = 0.989N_{t-1}^2 + m_t^2 \qquad (2.b)$$

$$m_t^2 = 0.38n_{t-1}^2 + 0.011n_{t-1}^3 - n_t^3 \qquad (3.b)$$

$$m_t^3 = 0.87n_{t-1}^3 \qquad (4.b)$$

$$N_t^3 = 0.982N_{t-1}^3 + m_t^3 \qquad (5.b)$$

$$N_t^3 = 0.008V_t + 0.03n_t^2 + 0.07n_t^3 \qquad (6.b)$$

Pattern of Balanced Growth

Assuming that economic variables develop with a constant rate of growth, it is possible to find a path of development of educational variables showing the same rate of growth. This pattern of development, as already mentioned, is called "Balanced Growth". For a system to move along such lines, the initial conditions (to be indicated by a suffix t = 0) have to qualify certain requirements.

In order to establish the above-mentioned conditions

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[1]Iran, Plan and Budget Organization (mimeo, n.d.).

for the case of Iran, assuming the exponential pattern of growth, i.e. $V_t = V_0\omega^t$ in which V_0 is the initial value of V, and ω is the rate of growth per six-year period, the following steps are taken:

Considering the annual rate of growth officially set for the Fourth Plan, say 9 per cent,[1] the rate of growth per six-year period should be:

$$\omega = (1 + 0.09)^6 = 1.68$$

Therefore, the time path of output would be:

$$V_t = V_0 1.68^t$$

Hence, the assumptions of the balanced growth imply:

$$N_t^2 = N_o^2 1.68^t \qquad N_t^3 = N_o^3 1.68^t$$

$$n_t^2 = n_o^2 1.68^t \qquad n_t^3 = n_o^3 1.68^t$$

$$m_t^2 = m_o^3 1.68^t \qquad m_t^3 = m_o^3 1.68^t$$

By substituting these assumptions in equations (1.b) to (6.b) of the model, we shall find the following conditions fulfilled by the initial values:[2]

$$N_o^2 = 0.025V_o \qquad N_o^3 = 0.011V_o$$

$$n_o^2 = 0.089V_o \qquad n_o^3 = 0.010V_o$$

$$m_o^2 = 0.010V_o \qquad m_o^3 = 0.005V_o$$

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[1]This rate was considered for gross national products of Iran by the Fourth Development Plan. Plan and Budget Organization, Tehran, 1968.

[2]See G. H. Baher, Appendix AA, pp. 200-201.

These equations determine the structure of the educational system. Supposing the year 1966 as the base, the values of the educational factors of Iran have been calculated for three consecutive periods. The results are shown in the following table (V-2).

Comments

In addition to all the objections being made to the balanced growth model, as were referred to in the previous chapter, there are a number of comments to be made about the application of such a model to the case of Iran.

The lack of long enough and sufficiently reliable time series of data could be mentioned as the main flaw in this operation. The validity of the results of any model, among other things, is directly based on how close its underlying assumptions are to reality. For instance, the assumptions of 9 per cent rate of growth for GNP and a uniform 6-year period for the time unit of any educational level, came out to be different from what in fact it was.

All in all the prediction made for the requirement of human capital for the Fourth Plan was different from what in fact it was.[1]

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[1]See Iran, "The Demand for and Supply of Educated People During the Fourth Plan," Plan Organization, Population and Manpower Bureau, 1974 (mimeo. in Persian).

Table V-2

Balanced Growth of the Educational System of Iran
For Assumed 68 percent Growth Rate Per 6 Years

Symbols	Variables	TIME PERIOD 1966 (Actual)	1966 (Estimated)	1966-72	1972-78	1978-84
V	Volume of Production (Millions of dollars)	6840 (1)	6840.0	11491.2	19305.2	32432.7
N^2	Humanpower with Secondary Education (000's)	174.3 (2)	171.0	282.3	482.6	810.8
N^3	Humanpower with Third-Level Education	53.2 (3)	75.2	126.4	212.4	356.8
n^2	Students in Secondary Schools	595.7 (4)	608.8	1022.7	1718.2	2886.5
n^3	Students in Third-Level Education	36.7 (5)	68.4	114.9	193.1	324.3
m^2	Humanpower with Secondary Education and Under 6 Years Employment	-	68.4	114.9	193.1	324.3
m^3	Humanpower with Third-Level Education and Under 6 Years Employment	-	34.2	57.5	96.5	162.2

Sources: (1) Ministry of Economy, Statistics Bureau Report (Tehran, 1968)
(2) and (3) Iran's Statistics Center, Report of the Population Census, V. 167, (Tehran, Feb. 1966)
(4) and (5) Ministry of Education (unpublished data)

* 1 Dollar = 75 Rials

3. Cost-Benefit Approach

Cost-benefit analysis is another approach applied for qualified humanpower planning in Iran. In this ground, the private and social rates of return to schooling are computed for five general fields of higher education as: (1) literature and humanities; (2) science; (3) business, public administration and economics; (4) agriculture and (5) engineering. The results of this are shown in the following Tables V-3 to V-6.[1]

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[1]The corresponding social and private rates of returns, as well as their differences, for each of the educational categories are calculated under the following considerations:

a) social costs = current and capital costs to government.
b) private costs = cost of books and tuition.
c) social and private benefits of education under their alternative assumptions for earning differentials due to education as: 0%, 60% and 40%.
d) all of the above computations under three alternative assumptions about the growth in real per capita income as: 0%, 3% and 5%.

See M. Rahmani, "The Application of a System Analysis Approach to Educational Planning in Iran," Quarterly Journal of Economic Research, 3 (23 & 24), 1971, pp. 5-32.

Table V-3 : Yearly average direct social and private cost of education per student for five fields of higher education (Rials 75.750 = $1)

Fields of study	Current costs to government	Capital costs to government	Tuition	Books	Total yearly social direct costs of education	Total yearly direct costs to individuals
Literature & Humanities	37710	25093	8500	1000	63803	9500
Science	86746	39724	10500	1000	127470	11500
Bus. & Pub. Administration & Econ.	36604	25093	8500	1000	62697	9500
Agriculture	151180	39724	10500	1000	191904	11500
Engineering	100333	39724	10500	2000	142057	12500

Table V -4 : Social rate of return for five fields of higher education

Fields of study	0% Growth in real per capita income			3% Growth in real per capita income			5% Growth in real per capita income		
	No A.A.(a)	60% Earn. Diff.(b)	40% Earn. Diff.(c)	No A.A.	60% Earn. Diff.	40% Earn. Diff.	No A.A.	60% Earn. Diff.	40% Earn. Diff.
Literature & Humanities	15.3	10.5	7.5	19.1	14.1	10.9	21.6	16.4	13.2
Science	14.2	9.7	6.8	18.1	13.3	10.3	20.7	15.7	12.6
Bus. & Pub. Administration & Econ.	18.5	12.9	9.4	22.4	16.6	12.9	25.1	19.0	15.3
Agriculture	13.8	9.3	6.5	17.7	13.0	10.0	[illegible]	15.5	12.4
Engineering	18.2	12.6	9.2	22.3	16.4	12.8	25.1	19.0	15.2

(a) No ability adjustment.
(b) 60% differential in earnings due to education.
(c) 40% differential in earnings due to education.

Source: M. Rahmani, Ibid. p.22 .

Table V -5 : Private rate of return for five fields of education

Fields of Study	0% Growth in real per capita income			3% Growth in real per capita income			5% Growth in real per capita income		
	No A.A.(a)	60% Earn. diff.(b)	40% Earn. diff.(c)	No A.A.	60% Earn. diff.	40% Earn. diff.	No A.A.	60% Earn. diff.	40% Earn. diff.
Literature & Humanities	20.0	14.0	10.3	23.7	17.5	13.7	26.1	19.8	15.9
Science	23.6	16.6	12.4	27.4	20.2	15.8	30.0	22.6	18.1
Bus. & Pub. Administration & Econ.	23.9	16.9	12.6	27.8	20.5	16.1	30.3	22.9	18.3
Agriculture	27.4	19.5	14.6	31.4	23.2	18.1	34.0	25.6	20.5
Engineering	30.7	21.9	16.5	34.8	25.7	20.1	37.5	28.2	22.5

(a) No ability adjustment
(b) 60% differential in earnings due to education
(c) 40% differential in earnings due to education

Table V -6 : Differences between social and private rates of return under different circumstances

Fields of study	0% Growth			3% Growth			5% Growth			Private share of direct costs of education
	No A.A.(a)	60% E.D.(b)	40% E.D.	No A.A.	60% E.D.	40% E.D.	No A.A.	60% E.D.	40% E.D.	
Literature & Humanities	4.7	3.5	2.8	4.6	3.4	2.8	4.5	3.4	2.7	14.88
Science	9.4	6.9	5.6	9.3	6.9	5.5	9.3	6.9	5.5	9.02
Bus. & Pub. Administration & Econ.	5.4	4.0	3.2	5.4	3.9	3.2	5.2	3.9	3.0	15.15
Agriculture	13.6	10.2	8.1	13.7	10.2	8.1	13.7	10.1	8.1	5.99
Engineering	12.5	9.3	7.3	12.5	9.3	7.3	12.4	9.2	7.3	8.79

(a) A.A. = ability adjustment
(b) E.D. = earning differentials

Source: M. Rahmini, <u>Ibid</u>.P.23.

Comments

As usual, in addition to the comments generally applicable to any cost-benefit approach to humanpower planning, as were discussed in the previous chapter, there seems to be some specific comments to be made in the application of this approach to the case of Iran.

In assessing the social cost of education, the direct costs to individuals (private costs) are excluded and only the costs to government (public costs) are considered as the social costs of education. This differs from our understanding of the social costs, as was discussed in the previous chapter, that encompasses both public and private costs.

The aggregation of the various fields of education into five general categories is errotic. For instance, in the field of science, treating physics and medicine the same, with the costs of the latter approximately two times more than that of the former, seems unjustifiable.

There are also a number of arbitrary assumptions with regard to the assumed growth rates for the real per capita income (0%, 3% and 5%) and alternative percentage differential in earnings due to education (a = 0.0%, b = 60% and c = 40%). The validity of these assumptions are all questionable.[1]

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[1]For example, the growth rate of the real per capita income during the Fourth Plan (1968-72) is announced officially as 8.6 per cent which is much higher than the maximum amount assumed here. See Bank Markazi Iran, Annual Report and Balance Sheet 1351, p. 15.

4. Employers' Opinion Approach

In the preceding sections, we analyzed the past performance of the planning strategic growth agents in the context of Iranian experience. The underlying models were mainly mathematically oriented and thus problematic. Because, in planning models, greater economic realism could be achieved through more sophistication and hence, greater mathematical complexity. In handling such complicated models, before anything else, a sufficient set of consistent data is needed; and if appropriate data is not available to achieve practical usability of the model, some simplifications seem necessary. This means to assume the reality to be much simpler than in fact it is. The existence of the assumptions as such is not a worry per se, but this danger exists that they might put us on the wrong track altogether.

In order to avoid such discrepancies, there is a growing tendency towards the application of simpler methods in the field of humanpower planning. Iran has not been an exception in this respect. This section is devoted to the analysis of the Bureau of Population and Manpower's most recent approach to forecasting the humanpower requirement of the Fifth Development Plan, in which the simplest method, i.e. the "Employers' Opinion Approach" (E.O.A.) is applied.

The E.O.A. is one of the simplest methods that have ever been employed both in more-developed and less-developed countries. This method is based on questionnaires sent to employers in which they are asked about the quantity and quality of humanpower they expect to hire during some coming periods of time. After the questionnaires are replied by employers, the next stage is summation over the employers' expected employment. By considering the likely number of deaths, retirement and net migration over the relevant period, we arrive at a forecast of the change in effective demand for different types of humanpower by the target year.

In the case of Iran, since enquiring about all the employers' opinions is an impossible task, the Bureau of Population and Manpower (B.P.M.) has adopted a sampling procedure with a sample set consisting of the following two subsets:[1]

a) Public Sector: 64 ministries and other governmental organizations, corporations and institutions (including affiliated ones).

b) Private Sector: i) 46 consulting engineers
ii) 129 construction and institutional corporations.

The purpose of the survey is mentioned as: "To determine the demand for additional humanpower on the bases of occupations and levels of education, during the performance

[1]Bureau of Population and Manpower, "Humanpower Requirement in the Fifth Development Plan (1973-78)," Plan and Budget Organization, Tehran, March 1975 (mimeo).

years of the Fifth Development Plan (1973-78), in order to employ the necessary policies to achieve equilibrium between the country's supply of and demand for humanpower."[1]

On the basis of this survey, the required new humanpower during the Fifth Plan, as a whole, amounts to about 1 million (749,065 in the public sector and 197,084 in the private sector). Extracted from the results of the survey, the following tables (V-7 and V-8) are designed such that to show the required humanpower during the period of the Fifth Plan at both levels of public and private sectors. In so doing, humanpower requirements are shown both by occupation and by the level of education. This helps to recognize where the bottlenecks of humanpower exist.

Comments

In order to evaluate the B.P.M.'s estimation of the humanpower requirements during the Iranian Fifth Plan, we should look at the applied method, i.e. "Employers' Opinion Approach" from two angles: 1) practical implementation, and ii) theoretical foundation.

i) Flaws in practical implementation of E.O.A.: The application of the E.O.A. in the way adopted by B.P.M. has various flaws. For the sake of brevity we avoid going into detailed

[1]Since the report is in Persian language, our translation might not accord exactly with the original text. This statement applies equally to all other non-English sources referred to in the present work.

lists of its questionable points; hence, we mention some general comments:

(1) The sampling procedure is a very sensitive approach to the real life. A sample to be a good representative of its society should fulfill some qualifications. These requirements are discussed in any elementary statistics text-book and we do not see it appropriate to repeat them here. However, the application of E.O.A. to the Iranian humanpower through sampling procedure does not fulfill most of the sampling qualifications. Whether this has been happening due to the difficulties prevailing usually in any L.D.C. or something else, is beyond the main line of the present section.

Table V-7

Humanpower Requirements During the Fifth Plan (1972-77)
(General Occupational Distribution)[1 & 2]

(Man-Year)

Group	Occupation	Public Sector	Private Sector	Total
0,1	Professional, technical	330702	27048	357750
2	Managerial, administrative, executive	44890	4886	49776
3	Clerical and related	62397	8965	71362
4	Sales and related	2061	235	2296
5	Services	74712	1422	76134
6	Agricultural, husbandry, forestry and hunting[3]	7763	----	7763
7,8,9	Mining, quarrying and well drilling and transportation	50518	43299	93817
X	Others: occupationally unclassified	176022	111229	287251
1-X	Grand Total	749065	197084	946149

Notes:

1. This Table is extracted from Tables 1 and 4 of "Humanpower Requirement in the Fifth Development Plan (1972-77)", Bureau of Population and Manpower, Plan and Budget Organization, Tehran, 1975.

2. The numbers appeared in this table imply the flow of humanpower required in addition to the stock being left from the Fourth Plan (Persian mimeo.), pp. 5 and 22.

3. No figure is given for the 6th group of occupation at the private level.

Table V-8

Humanpower Requirements During the Fifth Plan (1972-1977)
(Educational Distribution)[1]

(Man-Year)

Level of Education	Public Sector	Private Sector	Total
Less than elementary	624	155	769
Elementary	251030	129017	380047
Ninth grade[2]	67224	29059	96283
Secondary	240960	17903	418863
Post secondary	91577	9805	101382
B.A. (or B.S.)	63879	4385	68264
M.A. (or M.S.)	16565	6388	22953
Doctorate	10331	361	10692
Non-specified	6875	11	6886
Grand Total	749065.	197084	946149

Notes: 1. This table is extracted from Tables 3 and 6 of "Humanpower Requirements in the Fifth Development Plan (1973-78)", Bureau of Population and Manpower, Plan and Budget Organization, Tehran, 1975 (Persian Mimeo.), pp. 20 and 32.

2. Grade nine category is no more significant in the Iranian educational system; it is replaced by "Guidance Cycle" which is equivalent to grade eight.

(2) The classification of required humanpower according to various occupations is useful for any humanpower budgeting. What is technically more important is the classification of occupations per se. The national humanpower survey in 1958 for the first time classified non-agricultural employees into one of the 240 three-digit occupational classifications contained in the I.L.O.'s preliminary "standard classification of occupations." Later on, I.L.O. has revised its preliminary classification into 1345 five-digit occupations in terms of functions and duties involved in the occupations, without any reference to their corresponding educational qualifications.[1]

The B.P.M.'s classification, though, does not accord exactly with any of these two occupational classifications, still is a triumph of ingenuity and patience. The estimation of required humanpower on the basis of the level of education is another positive aspect of the approach which facilitates the understanding of the need for strategic people. However, the arbitrary aggregation of detailed occupations into semi-detailed and general occupational groups is far from accurate. For instance, the inclusion of "printing and book reporting workers" in the "mining, quarrying and well-drilling and transportation" category ~~seems~~

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[1] I.L.O., "International Classification of Occupations," (Geneva: International Labour Office, 1958).

strange."[1]

In the case of "educational classification," also, lots of ambiguity is involved. The classification of education into eight categories is not a problem per se. The problem is aggregating the holders of similar degrees with different qualifications into the same category. In other words, disregarding the usual difficulties involved in quantifying the qualitative aspects of education, the heterogeneity of the levels of education at different educational institutions, which produce the same academic degrees, is really a problem. For instance, in the doctorate category, whereas some West European universities require only a paper in addition to a B.A., at some North American universities, the candidate should be a qualified B.A. and M.A. graduated from recognized universities with the minimum grades B and spend five years on the average to fulfill course requirements, comprehensive examinations in general theories and special fields, an advanced dissertation and the knowledge of a minimum of two or three modern languages.

In addition to the above technical shortcomings, the B.P.M.'s approach has not produced a consistent result. The estimated aggregate humanpower requirement in this approach is about 1 million, whereas the possible supply of

[1]B.P.M., Tables 2 and 5, pp. 18 and 29.

humanpower is mentioned to be about 1.4 million.[1] If we accept these two figures, there seems to be 0.4 million surplus rather than shortage which is admitted in the report. Moreover, none of these estimations coincide with the officially published numbers for the revised version of the Fifth Development Plan.[2] In accepting any of these figures as a more accurate base, if we are supposed to, we are not only faced with making decisions about "whether the egg is created earlier or the hen," but also the puzzle "where the cock is coming from." All in all, although the problems concerning the practical implementations of E.O.A. by B.P.M. are not limited to the above-mentioned ones, for the sake of brevity we confine our comments to the important ones; hereunder, some of the shortcomings underlying in the theoretical foundations of the E.O.A. itself will be pinpointed.

ii) Flaws in theoretical foundations of E.O.A.: The Employers' Opinion Approach is based on the assumption that employers themselves forecast their employment trend. If they do not do so, or if their forecasting is not correctly made, the E.O.A. is self-defeated.

Forecasting the personnel requirement is an affair which few firms, even in more-developed countries, have

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[1] Ibid., Introduction.

[2] P.B.O., Fifth Development Plan (1973-78), revised version, Tehran, September 1974.

developed systematically.[1] Therefore, most of the firms will fill out the questionnaires by guessing. This means that E.O.A. is not a reliable method, especially in medium and long-term forecasting. Another weakness arises if employers are not also asked about their expected production level. In this case, their replies to their demand for humanpower could not be checked for internal consistency. In the case of firms operating under oligopolistic competition, without the knowledge about the action of the rival firms, the argument concerning the impossibility to check internal consistency applies even if the expected growth rate of their output is stipulated in the questionnaire. This is the case for all other firms which cannot predict their future share in the market.

Nevertheless, despite all its shortcomings, the Employers' Opinion Approach has been widely applied all over the world.[2] But, like Tinbergen-Correa and Bos's models,

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[1] For example, only one-fourth of British metal firms are engaged in forecasting their humanpower needs two years ahead. See Ministry of Labor, U.K., The Metal Industries: A Study of Occupational Trends in the Metal Manufacturing and Metal Using Industries, Manpower Studies No. 2, 1965.

[2] In addition to some LDC's, a number of MDC's have also applied this method. Examples in this regard are U.S., U.K., Canada, France and Sweden. In U.K. alone, three humanpower forecasts have been made in 1956, 1959 and 1962 by applying E.O.A. See Gannicott and Blaug: "Manpower Forecasting in the U.K. since Robbinson: A Case Study of a Science Lobby," Higher Education Review, (September 1969).

the worldwide application of a method does not necessarily confirm its accuracy and usefulness. This notion leaves room for further advancements, the purpose of which will be followed in the next section.

5. Verdoorn Coefficient Approach (V.C.A.)

According to the results of a number of national and international studies, it is conceived that there exists a link between growth of employment and growth of output.[1] What the nature of this link is and how it could be chosen is evidently subject to detailed analysis of any specific case. However, one of the simplest conceivable forms which is applied in some studies is as follows:

$$X_t^j = A {L_t^j}^{v^j} \qquad j = 1 \ldots n \qquad (1)$$

where: X_t^j = value added in sector j at time t

L_t^j = employment provided by sector j at time t

v^j = coefficient which links X_t^j to L_t^j

A = constant

Taking logarithms in (1) and differentiating it with respect to time we find:

$$\dot{X}^j = v^j \dot{L}^j \qquad (2)$$

[1] See O.E.C.D., p. 39.

where dots (·) refer to the growth rates.[1]

Equation (2) implies that the growth rate of output in any sector ($\dot{X}^j$) is equal to v^j times the rate of employment in that sector ($\dot{L}^j$). The coefficient v^j is usually called Verdoorn coefficient and normally is expected to be more than one ($v^j > 1$).

The V.C.A. is considered by I.L.O. as the second best approach for the case of Iran by stating that: "We cannot pretend that it provides a good link between output on the one hand and employment on the other. However, it does serve in the absence of a superior method and at least makes abundantly clear that the prime point about employment, the employment growth depends on output growth."[2] Assuming such a relation as equation (2), it could be argued that given the values of v^j, factors which determine levels of value added

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[1] The procedure in this calculation is as follows:

$$\log X_t^j = v^j \log L_t^j + \log A$$

$$\frac{d\log X_t^j}{d_t} = v^j \frac{d\log L_t^j}{d_t}$$

defining $\frac{1}{X_t^j} \cdot \frac{d\,X^j}{d_t} = \dot{X}^j$ and $v^j \frac{1}{L_t^j} \cdot \frac{L^j}{t} = V^j \dot{L}^j$ makes $\dot{X}^j = v^j \dot{L}^j$

[2] G. Pyatt with J. Bharier, R. Lindley, R. Mabro and Y. Sabolo, Employment and Income Policies for Iran. Mission Working Paper No. 12, "Methodology for Macro-Economic Projections. (Geneva: I.L.O., 1973).

in the sectors of the economy will also determine the levels of employment in those sectors. Therefore, in order to determine the level of required humanpower we should know the predetermined values of $\dot{X}^j$ and v^j.

a. Determination of $\dot{X}^j$: The value of $\dot{X}^j$ is usually given by a macro-economic model. For example, I.L.O. has estimated the value added in the sectors of the Iranian economy by applying a macro-consistency model which is very sophisticated *per se*.[1] In so doing, given the exogeneous variables, the humanpower requirement could be measured by gross output and income which are endogenously determined in I.L.O.'s model.[2] The linkage between estimated levels of required humanpower and the macro-plan of the economy is a very significant step which could be considered in the process of humanpower planning. However, the simplifying assumptions, as usual, are the most problematic aspects of this approach which we will come back to later on.

b. Determination of v^j: Verdoorn coefficients are to be estimated by regressing the employment growth rates on the rates of growth of value added in each sector. In the absence of an appropriate time series, alternative procedures

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[1] Ibid.; also P. B. Clark, "Intersectoral Consistency and Macro-economic Planning," in C. R. Blitzer, P. B. Clark, L. Taylor (eds.), Economy-wide Models and Development Planning, Oxford University Press, 1975, pp. 138-148.

[2] See equation (III.6) in Pyatt et al., p. 50, or equation (4.4) in P. B. Clark, p. 142.

should be utilized. In the case of Iran, the Verdoorn coefficients have chosen to be equal to their corresponding averages for six countries with some similarities to Iran.[1]

In the following Table V-9, considering the latest growth rates presumed for value added of major economic sectors (at fixed prices of 1972),[2] we have estimated the total humanpower demand by the end of the Fifth Development Plan.

Comments

Due to the lack of data and information about various qualified humanpowers in each sector, we were unable to estimate the humanpower requirements on the bases of qualifications. However, our estimation of the total employment by the end of the Fifth Plan could be considered as the second best approach.

Although the estimates of employment based on V.C.A. are not significantly different from the Fifth Plan's figures, nonetheless, the fundamental bases of this approach are rather unreliable. To have some idea about the inherent weaknesses of this approach, we briefly pinpoint the major pitfalls of this approach.

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[1]The chosen six countries are Finland, Japan, Philippines, Portugal, Puerto Rico and Yugoslavia. These countries are selected from an eighteen-countries sample studied recently by I.L.O.

[2]Revealed data from the revised version of the Fifth Development Plan, Iran, Plan and Budget Organization, 1974.

Table V-9

Estimation of Humanpower Requirements of the Fifth Development Plan on the Basis of Verdoorn's Coefficient Approach

Major Sector	Annual Rate of Growth of Value Added (Average %)[1]	Verdoorn Coefficients[2]	Growth Rate of Employment (%)	Total Employment (1000 Man-Year) 1972	1977
Agriculture	8.1	3.7	10.9	3900	4325.0
Oil	138.2	7.7	89.6	8	15.2
Industries and Mines	25.8	2.5	51.2	2492	3767.9
Services	22.7	2.3	49.3	2475	3695.2
Total	43.3	6.6	33	8875	11803.3

Notes:

1. These rates are calculated on the basis of the Fifth Plan's forecast of value added for the year 1972. See "Iran's Fifth Plan, A Guide prepared by Kayhan Research Associates," Tehran, p. 16.

2. The Verdoorn coefficient for agriculture coincides with the I.L.O.'s one; however, in our definition livestock is also included in agriculture sector. The corresponding coefficient for industries and mines accords with the I.L.O.'s Verdoorn coefficient for Mining and Trade manufacturing. Finally, our coefficient for services accord with I.L.O.'s coefficient for domestic services.

3. Our figures for employment in 1972 for major economic sectors are based on Pyatt's estimation for employment respectively in primary, secondary and tertiary sectors, except for oil which is taken out from secondary sectors and is treated separately. See I.L.O.'s report, p. 98.

Although it is claimed that the formulation of equation (1) is justifiable from a number of national and international studies, in addition to the creditability of these studies, there seems to be other fundamental questionable points in pretending that equation (1) provides a good link between output in a sector and employment in that sector. For instance, in the case of Iran, despite the implication of official figures about a low level of unemployment, there exists certainly a great amount of unemployment and underemployment which can vary over time. Therefore, it is very likely that the growth of output results in reducing the level of underemployment without having any effect on the level of employment. Moreover, even if we suppose the levels of income and output will determine employment, evidently we have disregarded or degraded the job variations which could be caused by other effects such as i) changes in product mix, ii) changes in composition of output and iii) inconceivable inequality of income distribution.[1]

In the I.L.O.'s report, the determinants of employment are set out in such a way as to include a number of different effective elements such as import substitution, taxation policies and changes in the pattern of consumption. The

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[1]Although it is very difficult to judge about the amount of unemployment in the absence of accurate data provided by effective general employment agencies and/or social security provisions, we may admit intuitively that in spite of labor shortages of some sort, there are labor surpluses of other sorts, mainly non-qualified, which are generally underemployed.

effects of these various determinants of employment are shown schematically in the following figure V-1. However, without discussing how these effects are taken into account, we can see the shortcomings of this approach from other angles, namely, the existence of other factors affecting the output which might make the simultaneous expansion of output and employment not to be feasible. These factors include changes in balance of payments, abrupt changes in total savings and choice of techniques. Significant changes in balance of payments and/or total savings may be even of opposite effects to what equation (1) dictates. In the case of the possibility of the choice of technique within sectors, the Verdoorn coefficient (v) will be no more constant. Hence, a variable v, if it does not make the predictions of employment completely impossible,[1] could be best looked at as a crude way of proceeding.

Finally, in the Verdoorn coefficient approach, as in most of other humanpower planning models, the supply factors are totally disregarded. In other words, the employment situation might be affected by constraints imposed on it from supply side of the labor market. This is especially true for the sectors in which the level of employment depends more on the supply factors, such as population growth and migration,

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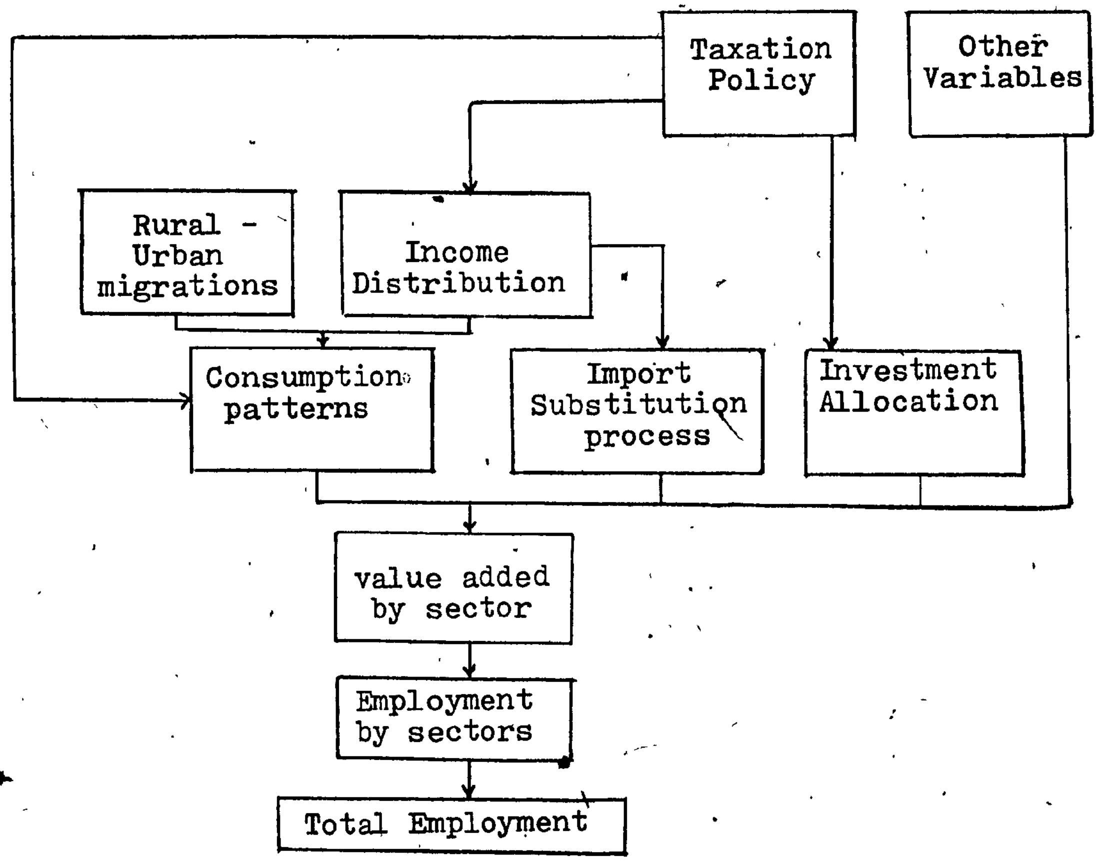
[1]The impossibility of employment prediction when v^j is variable arises where we are using other nations' values of v^j for our use as in the case of Iran.

Figure V-1

Determinants of Employment



*Source: Pyatt et al., p. 82.

than on demand factors. In such cases, Verdoorn coefficient is not very meaningful. Thus we can conclude that, regardless of all its flaws, the Verdoorn coefficient approach could be helpful under full employment assumption in sectors of the economy. An assumption which is more unlikely to occur in L.D.C.'s than V.C.A.'s assumptions themselves.

SUMMARY V

It is more than a couple of decades that the thought of humanpower planning has taken root in Iran. Since then, some efforts have been made in this regard by both official organizations as well as academic scholars. We had occasion to discuss all the models we had access to, namely: (1) Rule-of-Thumb Approach, (2) Balanced Growth Approach, (3) Cost-Benefit Approach, (4) Employers' Opinion Approach and (5) Verdoorn Coefficient Approach.

Except for the Employers' Opinion Approach, which is of an accounting nature, the underlying models of the other four approaches are based, more or less, on some economic notions. Therefore, their theoretical background should be analyzed. Since this job was done thoroughly in the previous chapter, here we emphasized more on the application of the models to the case of Iran.

From the comments we made on the application of the mentioned models and consideration of their theoretical drawbacks, as were explained earlier, it seems that none of the models has been satisfactory to enforce the critical job of qualified humanpower planning in Iran. Having this in mind and considering the need of economic development for preparing the right number of qualified people at the right time, leaves no room for obscuring the serious need for advancing knowledge in this regard.

In so doing, the limitation imposed by data is the main problem. Nevertheless, wishing for the improvement in this regard, we intend to develop a strategic humanpower model such as to avoid the shortcomings of the previous models as much as possible.

CHAPTER VI

AN ECONOMETRIC APPROACH FOR PLANNING THE STRATEGIC GROWTH AGENTS IN IRAN

Introduction

The lack of sufficient series of data and information about the skill composition of the labor force, as well as the factors affecting it, does not leave too much room for any comprehensive approach in this regard. Nonetheless, planning techniques could alleviate the difficult job of planners in less-developed areas.

With regard to planning the strategic growth agents in Iran, we are faced with an insufficiency of data about the composition of the labor force, wages rates, rental rates and capital stock. These bottlenecks prevent us from building up the usual labor demand functions based on the cost minimization approach. Therefore we have to look for alternatives.

Quasi-demand equation derived from production function seems to be a second best alternative. This is possible especially when we admit the constancy of technology during the plan span. However, the choice of appropriate production function which could be fitted properly to the production process in less-developed economies, is a problem *per se*. This is so especially when we come to compute the capital stock.

In the case of Iran, for instance, we have access only to three types of data (value added, employed labor and gross investment) disaggregated to four general economic sectors (agriculture, oil, industry and services) for thirteen years (1960-1972). Therefore, we do not have too much freedom of choice. This is the case not only in Iran but also in most of the less-developed countries. But, as mentioned earlier in this work, a planner cannot and should not wait until the data are improved. On his side, he should look for techniques which could be of use under the constraints imposed by data.

The methodology we are following in this respect for planning the strategic growth agents in Iran is a multi-stage approach, as opposed to simultaneous and optimal solution approaches available in the literature. In this approach, first we will decide upon appropriate production functions both for the economy as a whole as well as its four general economic sectors. After the choice of production function in each case, we solve it for labor as a function of output and capital obtaining what we call demand-type equation for labor.[1] At the end of this stage we will be able to project the demand for labor at the sectoral level for given future values of sectoral value added and capital stock.

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[1] These types of equations could not literally be called labor demand functions because they are not derived from cost minimization for a given level of output.

The next stage is to translate the sectoral demand for labor into skill requirements either by occupation or by education or by both. In so doing, again, we will be faced with the lack of data and hence, should look for a way out of this cul-de-sac. This is possible through the use of other countries' statistics. In the case under study, we will translate the sectoral labor demand into occupational categories through applying some skill composition vectors based on cross-sectional statistics for a set of fifty-three countries as well as a sub-set of eighteen selected countries.[1]

The choice of occupational disaggregation of the labor force in Iran will be made because of the availability of projected supply of labor to be compared with.[2] This comparison of supply and demand for disaggregated labor force at the occupational level will provide us with a picture of the shortages and surpluses of various humanpower at any time during the projection period. The analysis of these results which are referred to as "policy implications" could be a guide for policy makers if *ad hoc* decision-making is to be avoided.

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[1]O.E.C.D., Statistics of the Occupational and Educational Structures of the Labour Force in 53 Countries, Organization For Economic Co-operation and Development (Paris: 1970).

[2]Kayhan, Iran's Fifth Plan, pp. 31-32.

1. Demand For Humanpower: Theoretical Foundation

Considering the sectoral production function in general as:

$$Q_t = F\ (K_t,\ L_t) \qquad (1)$$

where:

Q = output

K = capital stock

L = labor input

t = time

such that once a particular technique of production is adopted it will remain the same during the given span of production. This choice of technique will determine simultaneously the amount of capital and the size of the labor force to be employed at any level of output.

Furthermore, if we also assume that for any level of output and capital input there is one, and only one level of demand for labor, we can set up an equation for labor requirement in which the quantity of labor demanded is given as a function of output and capital. That is:

$$L_t = F\ (Q_t,\ K_t) \qquad (2)$$

This sort of quasi-demand equation, or what we call demand-type equation is our main concern for the purpose of forecasting the humanpower requirement. Therefore, in what follows, first we fit the appropriate production functions both for the sectors as well as the economy of Iran. Based on the production functions we will derive the demand functions for the labor force as was depicted earlier.[1]

2. Estimating Production Functions

Among all possible types of production functions, the so-called Cobb-Douglas production function is favoured more than others. The reason for this underlies not only in the feasibility of its estimation but also for the nice properties it contains.[2]

The general format of a Cobb-Douglas production function is:

$$Q = A L^{a} K^{b} \tag{3}$$

where:

Q = output, L = labor input, K = capital, and

A, a, b = constants.

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[1]It is also possible to derive demand equations for labor at the sectoral level from an economy-wide production function with disaggregated factor inputs. See statistical appendix for alternative production functions as well as labor demand equations.

[2]A Cobb-Douglas production function such as (3) has the following properties:

i) changes in efficiency affect the constant A;
ii) changes in returns to scale are reflected in changes in the sum of a and b;
iii) changes in the relative intensity of labor inputs are corresponded inversely with relative values of a and b;
iv) a and b are elasticities of output with respect to labor and capital respectively.

Adopting this function for various sectors of the economy (j): we can write it as:

$$Q_t^j = A^j L_t^{j\,a^j} K_t^{j\,b^j} \qquad j = 1, 2, \ldots 4 \qquad (4)$$

where:

t = time and j = general economic sectors respectively as: agriculture, oil, industry and services.[1]

A similar function could be considered for the economy as a whole if all the variables are aggregated economy-wide (j = 5). This will be exercised here for comparative analysis purposes. However, the production function (4) can be written as a function linear in the parameters through logarithm operation as:

$$\ln Q_t^j = \ln A^j + a^j \ln L_t^J + b^j \ln K_t^j \qquad (5)$$

The coefficients of this equation could be estimated by running regression on the $\ln Q_t^j$, $\ln L_t^j$ and $\ln K_t^j$. The data for Q_t^j (value added) and L_t^j (labor employment) were available for thirteen years as per the following tables (VI-1 and VI-2). But there were no direct time series data available for capital stock (K_t^j). Therefore, we had to find a way to approximate it from investment data, through statistics available in this regard (Table VI-3). In so doing, we developed a model to generate capital stock as follows:

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[1]This classification of general economic sectors are adopted from the tradition made by the Bank Markazi Iran (Central Bank of Iran) in the National Income of Iran.

Table VI-1

Sectoral Value Added in Iran (1960-72)
At Constant Prices of 1960 (1)

(Billion rials - at factor cost)

Economic Sectors / Years	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
Agriculture (2)	85.4	87.1	87.9	88.8	90.3	92.2	99.5	103.0	111.1	119.7	123.4	129.1	124.4
Oil (3)	27.7	31.0	35.2	40.0	42.5	53.4	59.5	68.6	86.8	92.4	105.4	121.4	144.5
Industry (4)	45.3	49.0	52.8	57.8	65.7	69.2	81.6	92.0	106.3	119.8	130.9	144.4	170.6
Services (5)	107.7	113.1	114.1	119.8	126.0	140.9	158.8	172.6	187.0	212.6	235.2	268.2	310.6
G.D.P.	266.1	280.2	290.0	306.4	324.5	355.7	399.4	436.2	485.2	543.9	594.9	663.1	750.1

Notes: (1) This table is based on table 5 of the National Income of Iran (1960-72), (Tehran: Bank Markazi Iran, 1974), p. 16.

(2) Agriculture sector includes: farming, animal husbandry, forestry, fishery and hunting.

(3) Oil sector includes: income from exploration, exploitation, production and distribution of oil products accrued to Iranian factors of production (value added in national oil).

(4) Industry sector includes: manufacturing, mining, construction, water and electricity.

(5) Services sector includes: transportation, communication and telecommunication, banking, insurance and brokerage, domestic trade, housing rent, other private and public services.

Table VI-2

Sectoral Labor Employment in Iran
(1960-72)

(1000 Man-Years)

Economic Sectors / Years	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
Agriculture	3,417	3,513	3,604	3,672	3,749	3,836	3,827	3,774	3,861	3,808	3,784	3,718	3,678
Oil	30	32	34	36	38	40	42	44	46	47	48	50	50
Industry	1,328	1,371	1,412	1,372	1,531	1,569	1,672	1,844	1,947	2,069	2,192	2,372	2,515
Services	1,610	1,638	1,640	1,584	1,690	1,739	1,828	1,892	2,020	2,126	2,258	2,390	2,530
Total	6,385	6,554	6,690	6,664	7,008	7,184	7,369	7,554	7,874	8,050	8,282	8,530	8,773

Source: National Income of Iran (1960-72). (Tehran: Bank Markazi Iran, 1974), Table 43, p. 51.

Table VI-3

Sectoral Gross Investment in Iran (1960-72)

(Billion rials: at Constant Prices of 1960)

Economic Sectors / Years	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
Agriculture	3.7	3.8	3.9	3.5	3.9	4.4	5.5	5.2	7.9	7.9	8.9	9.0	14.4
Oil	4.7	5.0	5.0	4.4	5.0	5.7	9.6	7.3	11.1	12.8	12.2	8.9	13.6
Industry	26.4	27.7	27.5	24.7	27.6	31.6	43.3	48.0	57.9	65.5	67.6	72.5	85.5
Services	17.9	18.9	18.7	16.8	18.8	21.5	26.2	27.5	36.2	40.1	43.1	49.3	65.8
Total	52.7	55.5	55.0	49.4	55.3	63.2	84.6	88.0	113.1	126.3	131.8	139.7	179.3

Note: Data for the years 1966 to 1972 are adopted from National Income of Iran, table 94, p. 96. For the years 1960 to 1965 we have developed the data on the basis of average proportion of sectoral gross investment to the total gross investment by finding the corresponding ratios from the data of the years 1968 to 1972.

Generating Sectoral Capital Stock for Iran

Defining:

$$K_t = K_{t-1} + NI_{t-1} \quad (6)$$

where:

K_t = capital stock at the beginning of the period t

K_{t-1} = capital stock at the beginning of the period t-1

NI_{t-1} = net investment during the period t-1

and:

$$NI_{t-1} = I_{t-1} - dK_{t-1} \quad (7)$$

where:

I_{t-1} = gross investment during the period t-1

d = depreciation rate.[1]

By substituting (7) in (6) we find:

$$K_t = (1-d)\ K_{t-1} + I_{t-1} \quad (8)$$

Expanding equation (8) for t = 1, 2, ... n we find

$$K_1 = (1-d)\ K_o + I_o$$

$$K_2 = (1-d)\ K_1 + I_1$$

or by substituting for K_1 from previous equation:

---

[1]A 5% depreciation rate is assumed for all the sectors except for oil wherein the corresponding depreciation rate is assumed to be equal to 10%. These choices of depreciation rates which are arbitrary according to the international tradition give us a 7% depreciation rate for the whole economy. This rate is equal to the depreciation rate considered by the Bank Markazi for GDP. See National Income of Iran, p. 49.

$$K_2 = (1-d)^2 K_o + (1-d) I_o + I_1$$

and hence for K_3

$$K_3 = (1-d) K_2 + I_2$$

or by substituting for K_2, we find:

$$K_3 = (1-d)^3 K_o + (1-d)^2 I_o + (1-d) I_1 + I_2$$

Therefore, in general, we can write:

$$K_t = (1-d)^t K_o + \sum_{n=1}^{t} (1-d)^{t-n} I_{n-1} \qquad (9)$$

By substituting equation (9) in the production function (5) we find:

$$\ln Q_t^j = \ln A^j + a^j \ln L_t^j + b^j \ln \left[(1-d^j)^t K_o^j + \sum_{n=1}^{t} (1-d^j)^{t-n} I^j{}_{n-1} \right] \qquad (10)$$

We do not know the exact value of K_o^j, hence, if we treat K_o^j as a parameter this equation is no longer linear in nature and should be estimated using a non-linear estimation procedure. The resultant estimated coefficients of this operation are shown in the following table (VI-4).

Whereas the resultant regression statistics imply the acceptability of the operations in the last two sectors (industry and services), the corresponding t-statistics of the first two sectors (agriculture and oil) generally are not

Table VI-4

Regression Statistics: Sectoral Production Functions of the Iranian Economy (Non-Linear Estimation)

Economic Sectors (j)	Regression Statistics	$\ln \hat{A}^j$	$\hat{a}^j$	$\hat{b}^j$	$\hat{K}_o^j$	D-W	R^2
Agriculture		5.89 (0.41)	-0.35 (0.22)	0.43 (1.13)	21.60 (0.55)	1.07	0.951
Oil		-10.97 (-0.77)	2.61 (1.02)	1.27 (1.48)	74.97 (0.62)	1.78	0.995
Industry		-3.76 (-3.02)	0.59 (1.74)	0.68 (2.89)	113.14 3.72)	2.10	0.998
Services		-5.14 (-3.67)	0.88 (2.30)	0.66 (2.23)	130.20 (3.55)	2.01	0.996

Notes:
(1) These findings are resulted from running regression over equation (10).
(2) Data sources for Q_t^j, L_t^j and I_{n-1}^j are tables VI-1 to VI-3 respectively.
(3) The hypothetical initial values for a^j and b^j to be given to the computer are adopted from the similar regression equation which was linear under the assumption of $K_t = \sum_{n=1}^{t} I_n$. For the hypothetical initial value of K_o^j, on the basis of trial and error, finally we adopted values equivalent to ten times as the first year investment for all the sectors except for oil wherein it was adopted to be 100 times.
(4) Depreciation rates assumed for all the sectors were 5% except for oil which was 10%.
(5) The method applied for regressing such a non-linear equation was LSQ ran on the T.S.P. package for non-linear regression (FRML).
(6) Figures between parentheses are t-statistics.

significant. Naturally, we should think of the possibility of autocorrelation. To check upon such a hypothesis, we reestimated our non-linear equations while simultaneously corrected for autocorrelation. The results of this are shown in the following Table VI-5.

The results, while confirming the validity of the operations in sectors three and four, still imply the inappropriateness of the choice of initial capital by showing negative signs in the resultant corresponding estimated parameters. Therefore, following some searching procedure, we went on by giving some other values to initial capital stock in the first two sectors (Table VI-6). At the same time, to check the sensitivity of the other two sectors to the estimated initial capital stock, we ran the corresponding regressions with values of initial capital stock alternatively more than 20% and less than 20% of the values estimated from non-linear procedure (Table VI-7).

Table VI-6 shows the appropriateness of assuming zero for initial capital stock in both the agriculture and oil sectors. Moreover, the coefficients of labor and capital in the agriculture sector imply the constant returns to scale in this sector. This is confirmed by the results of the

Table VI-5

Regression Statistics: Sectoral Production Functions of the Iranian Economy (Non-Linear Estimation Corrected For Autocorrelation)

Economic Sectors (j)	Regression Statistics	$\widehat{\ln A^j}$	$\hat{a}^j$	$\hat{b}^j$	$\hat{K}_o^j$	$\hat{\rho}$	D-W	R^2
Agriculture		3.81 (0.29)	-0.01 (-0.004)	0.27 (3.27)	-4.27 (-10.45)	0.43 (1.76)	0.97	0.937
Oil		13.02 (0.72)	-0.29 (-0.14)	0.003 (0.07)	-63.87 (-24.22)	0.98 (14.82)	2.17	0.992
Industry		-3.07 (-1.63)	0.50 (1.07)	0.68 (2.32)	93.11 (3.04)	-0.13 (-0.29)	2.50	0.998
Services		-0.62 (-0.22)	0.04 (0.09)	1.02 (3.51)	100.79 (1.71)	0.53 (1.87)	2.10	0.997

Notes: (1) These findings are resulted from running regression over the equation (10) corrected for autocorrelation as follows:

$$\ln Q_t^j = \ln A^j (1-\rho) + a^j(\ln L_t^j - \rho \ln L^j_{t-1}) + b^j \left\{ \ln \left[(1-d^j)^t K_o^j + \sum_{n=1}^{t} (1-d^j)^{t-n} \cdot I_n \right] - \rho \ln \left[(1-d^j)^{t-1} K_o^j + \sum_{n=1}^{t-1} (1-d^j)^{t-1-n} \cdot I_{n-1} \right] \right\} + \rho \ln Q_{t-1}^j$$

(2) Regressions are made through assistance of the TSP language. The technique applied in all the cases is LSQ for non-linear regression (FRML).

(3) Figures between parantheses are t-statistics.

Table VI-6

Regression Statistics: Production Functions of Agriculture and Oil Sectors
(Assuming Different Initial Values For Capital Stock)

Economic Sectors (j)	Regression Statistics	$\ln \hat{A}^j$	$\hat{a}^j$	$\hat{b}^j$	$\hat{\rho}$	D-W	R^2	K_o^j (assumed)
Agriculture		-2.47 (-0.51)	0.74 (1.26)	0.31 (9.26)	0.54 (2.20)	1.87	0.976	0
Oil		-2.62 (-1.18)	1.26 (1.66)	0.62 (3.19)	0.45 (1.75)	1.77	0.990	0
Agriculture		-2.42 (-0.47)	0.73 (1.17)	0.32 (8.59)	0.55 (2.31)	1.82	0.975	2.5
Oil		-1.47 (-0.60)	0.84 (0.99)	0.74 (3.32)	0.45 (1.75)	1.85	0.990	2.5
Agriculture		-2.15 (-0.37)	0.68 (0.98)	0.35 (7.14)	0.60 (2.63)	1.70	0.972	• 5
Oil		-0.33 (0.12)	0.42 (0.43)	0.86 (3.31)	0.45 (1.75)	1.89	0.990	5

Notes: (1) These findings are resulted from running regression over the equation (5) respectively for the agriculture and oil sectors.

(2) Each sector is tested for three hypothetical values of initial capital stock (K_o^j = o, 2.5 or 5).

(3) Regressions are made through the assistance of TSP language. The technique applied for the first sector was Cochrane-Orcutt iterative technique (CORC) and for the second sector was Hidreth-Lu scanning technique (HILU).

(4) Figures between parentheses are t-statistics.

Table VI-7

Analysis of the Sensitivity of Industry and Services Sectors to Initial Capital Stock

Economic Sectors (j) / Regression Statistics	$\ln \hat{A}^j$	$\hat{a}^j$	$\hat{b}^j$	D-W	R^2	K_o^j (assumed)
Industry	-5.14 (-4.81)	0.81 (3.47)	0.62 (4.97)	1.75	0.996	135.77
Services	-6.55 (-6.06)	1.02 (4.07)	0.73 (4.80)	1.63	0.995	156.24
Industry	-5.67 (-6.36)	1.07 (6.28)	0.39 (5.39)	2.39	0.997	90.51
Services	-6.86 (-7.03)	1.30 (7.13)	0.41 (5.02)	2.25	0.996	104.16

Notes:
(1) These findings are resulted from running regression over the equation (5) respectively for industry and services sectors.
(2) Experimental K_o^j for both sectors are chosen to be 20 percent alternatively more or less than the corresponding amount of the initial capital stock obtained from the non-linear estimations as per Table VI-4.
(3) Regressions are made through the assistance of the TSP language. The method applied in all the cases is Cochrane-Orcutt iterative technique (CORC).
(4) Figures between parentheses are t-statistics.

t-test in this regard.[1]

Table VI-7 also approves the insensitivity of the industry and services sectors to the changes of capital. Therefore, based on the above experiments we adopted the following values for sectoral initial capital stock:

$$K_o^1 = 0, \quad K_o^2 = 0, \quad K_o^3 = 113.14, \quad K_o^4 = 130.20$$

Having the values of initial capital stock, depreciation rates and gross investments, it is possible to generate the values of sectoral capital stock for the sample period (1960-72) through the application of our model as per equation (9). The results of this computation are shown in the following table VI-8.[2]

Hence, having time series data for value added, labor inputs and computed capital stock make it possible to run regressions over the parameters of our linear form of production functions (equation 5). The resultant statistics are shown in the following table VI-9.

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[1]In order to test a Cobb-Douglas production function for constancy of return to scale ($H_o \sim a^j + b^j = 1$) the t-test could be shown as:

$$t = \frac{\hat{a}^j + \hat{b}^j - 1}{\sqrt{V(\hat{a}^j) + V(\hat{b}^j) + 2\,Cov(\hat{a}^j \hat{b}^j)}}$$

In the agriculture sector of Iran t = 0.0851 and hence H_o is accepted.

[2]For more detailed information see Statistical Annex (Appendix C).

Table VI-8

Computed Capital Stock of Iran Over the Observation Period (1960-72)

(billion rials: at constant prices of 1960)

Years	Economic Sectors	Agriculture	Oil	Industry	Services	Economy
1960		0.	0.	113.140	130.200	243.340
1961		3.70000	4.70000	133.883	141.590	283.873
1962		7.31500	9.23000	154.889	153.411	324.844
1963		10.8493	13.3070	174.644	164.440	363.241
1964		13.8068	16.3763	190.612	173.018	393.813
1965		17.0164	19.7387	208.682	183.167	428.604
1966		20.5656	23.4648	229.847	195.509	469.387
1967		25.0373	30.7183	261.655	211.933	529.344
1968		28.9855	34.9465	296.572	228.837	589.341
1969		35.4362	42.5518	339.644	253.595	671.227
1970		41.5644	51.0967	388.162	281.015	761.838
1971		48.3862	58.1870	436.353	310.064	852.991
1972		54.9669	61.2683	487.036	343.861	947.132

Table VI-9

Finalized Regression Statistics: Sectoral and Aggregate Production Functions of the Iranian Economy

Economic Sectors (j) / Regression Statistics	$\ln \hat{A}^j$	$\hat{a}^j$	$\hat{b}^j$	$\hat{\rho}$	D-W	R^2	K_o^j (adopted)	Method Applied
Agriculture	-2.47 (-0.51)	0.74 (1.26)	0.31 (9.26)	0.54 (2.20)	1.87	0.976	0	CORC
Oil	-2.62 (-1.18)	1.26 (1.66)	0.62 (3.19)	0.45 (1.75)	1.78	0.990	0	HILU
Industry	-5.29 (-5.92)	0.93 (4.72)	0.51 (5.36)	-	2.11	0.997	113.14	OLSQ
Services	-6.57 (-6.45)	1.15 (5.49)	0.56 (5.09)	-	1.99	0.996	130.20	OLSQ
Economy	-4.78 (-1.36)	0.68 (1.41)	0.76 (5.77)	0.55 (2.27)	2.11	0.998	243.34	CORC

Notes: (1) These statistics are resulted from running regression over equation (5).
(2) Figures between parentheses are t-statistics.
(3) Regressions are made by applying the TSP language. The best fits in agriculture sector and economy have been possible through the application of Cochrane-Orcutt iterative technique. In the case of oil sector, the Hildreth-Lu scanning technique (HILU) and for other sectors (industry and services) the usual OLSQ technique are applied.

3. Estimating Equations For Humanpower Requirements

The form of the estimating labor demand-type equations both for the sectors of the economy as well as the economy as a whole could be derived from production functions we arrived at in the previous section as:

$$\ln Q_t^j = \ln A^j + a^j \ln L_t^j + b^j \ln K_t^j \tag{11}$$

This could be done by solving equation (11) for $\ln L_t^j$. The resulting equation which is, hence, a demand-type of equation is of the following form:[1]

$$\ln L_t^j = B^j + f^j \ln Q_t^j + g^j \ln K_t^j \tag{12}$$

where: B^j, f^j and g^j are constants to be estimated.

The resultant regression statistics on the basis of this equation are summarized in table VI-10. The corresponding coefficients of these equations are needed for humanpower forecasting purposes in the next stage.

4. Prediction of Humanpower Requirement

Having the estimated values for the coefficients of the labor demand equation (12) makes it possible to predict the demand for humanpower in the future if we could project the corresponding values of independent variables in the equation. Therefore, we are in need of projected values for sectoral value added as well as sectoral capital stock for the plan span.

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[1]We estimated these equations directly instead of solving the estimated production functions. This was done to minimize the residual sum of squares for $\ln L_t^j$ rather than for $\ln Q_t^j$.

Table VI-10

Regression Statistics: Sectoral and Aggregate Demand-Type Functions For Humanpower in Iran

Economic sectors (j) \ Regression Statistics	$\hat{B}^j$	$\hat{f}^j$	$\hat{g}^j$	$\hat{\rho}$	D-W	R^2
Agriculture	7.84 (27.08)	0.16 (1.10)	-0.10 (-3.16)	0.63 2.81	2.80	0.907
Oil	3.49 (16.62)	0.11 (3.21)	-0.02 (-1.29)	0.81 (4.82)	2.11	0.995
Industry	5.44 (36.44)	0.74 (4.72)	-0.23 (-1.54)	-	2.00	0.989
Services	5.48 (35.55)	0.65 (5.49)	-2.24 (-1.72)	-	2.05	0.988
Economy	7.20 (107.88)	0.18 (3.5)	0.10 (2.3)	-	2.22	0.993

Notes: (1) These statistics are resulted from running regression over equation (12).

(2) Figures between parentheses are t-statistics.

(3) Regressions are made by applying the TSP language. The best fits in the first two sectors have been possible through the application of Cochrane-Orcutt iterative technique (CORC). In the other two sectors as well as the economy, the usual technique of OLSQ is applied.

Projection of Sectoral Value Added in Iran (1973-82)

Considering a period of ten years for our planning, which covers two Iranian medium-term plans (Fifth Plan: 1973-1977 and Sixth Plan: 1978-1982), the future sectoral value added are to be projected through the growth rates which are exogenously determined by concerned authorities.

The average growth rates of sectoral value added in the two previous plans (Third and Fourth Plans: 1963-72) have not been satisfactory to the I.L.O.'s mission which were helping the preparation of the Fifth plan.[1] Therefore, on the basis of their survey of the economy, the I.L.O. team proposed a modified version of the growth rates. But, incomparable to their proposal, the growth rates considered in the Fifth plan became drastically different from what the I.L.O. team suggested. The reason for such an abrupt change in the expected growth rates of the sectoral value added in the Fifth plan, was the sudden change in the oil revenues and hence the prevalence of foreign exchange which could facilitate the capital investment in various sectors of the economy.

The three sets of growth rates for sectoral value added are shown in Table VI-11. For the purpose of testing the feasibility of the Fifth plan we adopt the corresponding

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[1]A comprehensive employment strategy mission was sent to Iran by the International Labour Office in response to a request from the Government in mid-November 1971. Their report (Employment and Income Policies for Iran, I.L.O., Geneva: 1973) is based on the works of an inter-agency mission financed by the UNDP and organized by the I.L.O. with the assistance of the UN, UNCTAD, UNESCO, UNICEF, UNIDO, FAO, IBRD, IMF and WHO.

Table VI-11

Alternative Annual Growth Rates for Sectoral Value Added in Iran
(At Constant Prices)

(Percentage)

Economic Sectors / Sources of Data	Observation (1) Period (1960-72)	I.L.O. (2)	Fifth Plan (3) (1973-77)
Agriculture	3.5	2.4	7.0
Oil	15.1	20.0	51.5
Industry	12.4	12.5	18.0
Services	10.6	11.0	16.4
GDP	9.7	10.0	25.9

Notes: (1) Bank Markazi Iran, National Income of Iran (1960-72), Table 9, p. 19.
(2) Pyatt et al, "Methodology for Macro-economic Projection," pp. 24-28.
(3) Kayhan, Iran's Fifth Plan, p. 16.

growth rates for sectoral value added. However, as it is analyzed in the statistical appendix, at the same time that the I.L.O. proposed rates do not seem realistic, the Fifth plan's concerned growth rates also look very optimistic.[1] As a better alternative, the official growth rates over the observation period seem reasonable for extrapolation purposes. The corresponding projected sectoral values added are shown in the following Tables VI-12 and VI-13.

Projection of Capital Stock in Iran (1973-82)

As previously mentioned, to the best of our knowledge, there were no reliable sources of data about the capital stock in Iran, especially at the sectoral level. Since, for the projection of labor demand, both economy-wide as well as at the sectoral level, we were in need of capital stock data, as before, we had to look for a proxy. In so doing, we developed the corresponding figures by adopting our previous model for capital stock generation as:

$$K_t^j = K_o^j (1-d^j)^t + {}_{n=1}^{t} (1-d^j)^{t-n} I_{n-1}^j \qquad \begin{matrix} j = 1, 2, \ldots 4 \\ t = 1, 2, \ldots 10 \end{matrix} \quad (9)$$

where as before:

K_t^j = capital stock at time t in sector j

K_o^j = initial capital stock in sector j

d^j = depreciation rate in sector j

I_n^j = gross investment during any period n in sector j.

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[1]See Appendix B: Analysis of the Statistical Sources of Information.

Table VI-12

Projected Sectoral Value Added in Iran (1973-82)

(Alternative I: Projection Under the Fifth Plan's Conceived Growth Rates for Sectoral Value Added)

(billion rials: at Constant Prices)

Years	Economic Sectors	Agriculture	Oil	Industry	Services	Economy
1973		133.108	218.918	201.308	361.538	914.872
1974		142.426	331.660	237.543	420.831	1132.46
1975		152.395	502.465	280.301	489.847	1425.01
1976		163.063	761.234	330.755	570.182	1825.23
1977		174.477	1153.27	390.291	663.692	2381.73
1978		186.691	1747.20	460.544	772.537	3166.98
1979		199.759	2647.01	543.442	899.233	4289.45
1980		213.742	4010.23	641.261	1046.71	5911.94
1981		228.704	6075.49	756.688	1218.37	8279.25
1982		244.714	9204.37	892.892	1418.18	11760.2

Table VI-13

Projected Sectoral Value Added in Iran (1973-82)

(Alternative II: Projection Under the Observed Growth Rates for Sectoral Value Added)

(billion rials: at Constant Prices)

Years	Economic Sectors	Agriculture	Oil	Industry	Services	Economy
1973		128.754	166.320	191.754	343.524	830.351
1974		133.260	191.434	215.532	379.937	920.163
1975		137.925	220.340	242.258	420.210	1020.73
1976		142.752	253.612	272.298	464.753	1133.41
1977		147.748	291.907	306.063	514.017	1259.73
1978		152.919	335.985	344.015	568.502	1401.42
1979		158.272	386.719	386.672	628.764	1560.43
1980		163.811	445.113	434.620	695.412	1738.96
1981		169.544	512.325	488.513	769.126	1939.51
1982		175.478	589.686	549.088	850.654	2164.91

According to this formula, K_t^j could be computed for given values of K_o^j, d^j and I_{n-1}^j. The considered values for K_o^j are the corresponding values of capital stock computed for the year 1972. The values for d^j are assumed to be the same as before (5% for all sectors except for oil wherein the corresponding depreciation rate is assumed to be 10%).

Finally, for future values of the sectoral gross investment (I^j) there was no information available on a yearly basis. The Fifth plan's envisaged figures in this regard were aggregated and at current prices. However, the only information about gross fixed investment at fixed prices was the annual average growth rate for total fixed investment at 29.7 per cent. Therefore, we found some proxies for the annual growth rates based on this information in comparison with the pattern of investment during the Fourth plan. Moreover, as an alternative, we computed the corresponding rates over the observation period. The results are shown in Table VI-14.

Based on these two alternative series of growth rates for the sectoral gross investment, we have projected the sectoral gross investment and capital stock.[1] The resultant figures are shown in Tables VI-15 to VI-18.[2]

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[1]Sectoral depreciation rates are assumed to be the same as before: 5 per cent in all sectors except for oil where its corresponding rate is assumed to be 10 per cent.

[2]For more information see Statistical Annex (Appendix C).

Table VI-14

Alternative Growth Rates For Projecting the Sectoral Gross Fixed Investment in Iran

Economic Sectors / Data	Investment During the Fourth Plan (1) (billion rials constant prices)	% share in total	Investment During the Fifth Plan (2) (billion rials current prices)	% shown in total	Fifth Plan's Annual Growth Rates (Alternative I) %	Observed Annual Growth Rates (Alternative II) %
Agriculture	48.1	7	309.2	7	29.7	12
Oil	58.6	8	791.2	17	50.8	9
Industry	349.0	51	1323.2	28	14.9	10
Services	234.5	34	2275.2	48	39.1	11
Economy	690.2	100%	4698.8	100%	29.7	11

Sources: (1) National Income of Iran (1960-72), Bank Markazi (Tehran, 1974).
(2) Iran's Fifth Plan, Kayhan (Tehran, 1975).

Table VI-15

Projected Sectoral Gross Fixed Investment For Iran (1973-82)
(Alternative I: Projection Under the Fifth Plan's Conceived Growth Rates For Sectoral Investments)

(billion rials: at constant prices)

Years	Economic Sectors	Agriculture	Oil	Industry	Services	Economy
1973		18.6768	20.5088	98.2395	91.5278	228.953
1974		24.2238	30.9273	112.877	127.315	295.343
1975		31.4183	46.6383	129.696	177.095	384.848
1976		40.7495	70.3306	149.021	246.340	506.440
1977		52.8521	106.059	171.225	342.659	672.794
1978		68.5492	159.936	196.737	476.638	901.861
1979		88.9083	241.184	226.051	663.003	1219.15
1980		115.314	363.705	259.733	922.238	1660.99
1981		149.562	548.468	298.433	1282.83	2279.30
1982		193.982	827.089	342.899	1784.42	3148.39

Table VI-16

Projected Sectoral Gross Fixed Investment for Iran (1973-82)
(Alternative II: Projection Under the Observed Growth Rates For Sectoral Investments)

(billion rials: at constant prices)

Years	Economic Sectors	Agriculture	Oil	Industry	Services	Economy
1973		16.1280	14.8240	94.0500	73.0380	198.040
1974		18.0634	16.1582	103.455	81.0722	218.749
1975		20.2310	17.6124	113.801	89.9901	241.634
1976		22.6587	19.1975	125.181	99.8890	266.926
1977		25.3777	20.9253	137.699	110.877	294.878
1978		28.4230	22.8086	151.468	123.073	325.773
1979		31.8338	24.8613	166.615	136.611	359.922
1980		35.6539	27.0989	183.277	151.639	397.668
1981		39.9323	29.5377	201.605	168.319	439.393
1982		44.7242	32.1961	221.765	186.834	485.519

Table VI-17

Projected Sectoral Capital Stock For Iran (1973-82)

(Alternative I: Projection Under the Fifth Plan's Conceived Growth Rates For Sectoral Investments)

(billion rials: at constant prices)

Years \ Economic Sectors	Agriculture	Oil	Industry	Services	Economy
1973	66.6185	68.7415	548.184	392.468	1076.01
1974	81.9644	82.3761	619.014	464.372	1247.73
1975	102.090	105.066	700.941	568.469	1476.57
1976	128.404	141.198	795.590	717.141	1782.33
1977	162.733	197.408	904.831	927.624	2192.60
1978	207.449	283.726	1030.81	1223.90	2745.89
1979	265.625	415.290	1176.01	1639.34	3496.27
1980	341.252	614.945	1343.26	2220.38	4519.84
1981	439.504	[illegible]17.155	1535.83	3031.60	5924.09
1982	567.091	1373.91	1757.47	4162.85	7861.32

Table VI-18

Projected Sectoral Capital Stock For Iran (1973-82)
(Alternative II: Projection Under the Observed Growth Rates For Sectoral Investments)

(billion rials: at constant prices)

Years / Economic Sectors	Agriculture	Oil	Industry	Services	Economy
1973	66.6185	68.7415	548.184	392.468	1076.01
1974	79.4156	76.6913	614.825	445.883	1216.81
1975	93.5082	85.1803	687.539	504.661	1370.89
1976	109.064	94.2745	766.962	569.418	1539.72
1977	126.269	104.045	853.795	640.836	1724.94
1978	145.333	114.566	948.803	719.671	1928.37
1979	166.490	125.918	1052.83	806.761	2152.00
1980	189.999	138.187	1166.91	903.034	2398.03
1981	216.153	151.467	1291.74	1009.52	2668.88
1982	245.278	165.858	1428.76	1127.36	2967.26

Predicted Sectoral Demand For Humanpower (1973-82)

Through retrieving the coefficients of the sectoral demand-type functions for humanpower (Table VI-10), it is possible to compute fitted values of the labor demand for alternative sets of projected values of the right hand variables. Accordingly, the sectoral demand for humanpower are predicted under the following two sets of assumptions:

Alternative I: Fifth plan's conceived growth rates for both sectoral value added and gross investments.

Alternative II: Observed growth rates for both sectoral value added and gross investments. The results of these alternative predictions are shown respectively in Tables VI-19 and VI-20.

5. Prediction of Demand for Skills in Iran (1973-82)

The skill composition of the labor force are usually measured either by its occupational structure or by its educational qualifications or by both. However, as was mentioned earlier, for the case of Iran we did not have sufficient information about any of these two structures to look for meaningful relationships between them and possible explanatory variables. Therefore, the second best alternative approach was to get assistance from other countries' statistics on a cross-sectional basis. After knowing the demand for humanpower in any sector, assuming that the composition of labor force does not change during the plan span,

Table VI-19

Predicted Demand For Humanpower in Iran (Sectoral and Aggregated: 1973-82)
(Alternative I: Prediction Under the Fifth Plan's Conceived Growth Rates)

(1000 Man-Year)

Years \ Economic Sectors	Agriculture	Oil	Industry	Services	Economy (Aggregated)	Economy (Total)
1973	3647.18	54.1749	2768.05	2715.19	9274.79	9184.59
1974	3610.09	56.5123	3043.59	2880.31	9785.39	9590.51
1975	3568.92	58.8639	3344.42	3030.88	10375.9	10003.1
1976	3524.72	61.2378	3672.96	3166.60	11059.5	10425.5
1977	3478.37	63.6480	4031.92	3288.79	11850.3	10862.7
1978	3430.59	66.1100	4424.23	3399.65	12763.9	11320.6
1979	3381.94	68.6377	4853.11	3501.67	13817.0	11805.4
1980	3332.85	71.2426	5322.09	3597.23	15027.1	12323.4
1981	3283.64	73.9338	5835.05	3688.35	16413.3	12881.0
1982	3234.55	76.7187	6396.22	3776.66	17995.8	13484.2

Note : The figures under the title "economy total" indicate the summation of corresponding sectoral demand for humanpower while the last column figures show an economy-wide predicted labor demand under the alternative approach, i.e. aggregate demand function for labor. See Table VI-10. This is so for other table (VI-20).

Table VI-20

Predicted Demand For Humanpower in Iran (Sectoral and Aggregated: 1973-82)
(Alternative II: Prediction Under the Observed Growth Rates)

(1000 Man-Year)

Years \ Economic Sectors	Agriculture	Oil	Industry	Services	Economy (Aggregated)	Economy (Total)
1973	3627.74	52.5337	2669.82	2626.19	9112.18	8976.29
1974	3583.20	53.2298	2835.87	2720.74	9398.26	9193.04
1975	3543.66	53.9407	3014.30	2821.21	9691.54	9433.12
1976	3507.94	54.6658	3205.78	2927.56	9992.72	9695.94
1977	3475.20	55.4042	3411.05	3039.76	10302.5	9981.42
1978	3444.82	56.1557	3630.92	3157.88	10621.4	10289.8
1979	3416.34	56.9199	3866.29	3281.97	10950.0	10621.5
1980	3389.42	57.6965	4118.11	3412.16	11288.9	10977.4
1981	3363.77	58.4853	4387.40	3548.57	11638.6	11358.2
1982	3339.19	59.2864	4675.28	3691.38	11999.7	11765.1

it suffices to know the proportions of the skill components of the labor force in each economic sector to measure the size of skills demanded.

For the case of Iran, we adopted a cross-sectional approach on an international basis to find some average ratios of occupations in each economic sector. In so doing, we were lucky due to the availability of disaggregated data in this regard collected by O.E.C.D. from 53 countries (Table VI-21).[1] However, the job of finding the applicable ratios was not easy. This was so because most countries were not following a similar way of collecting the data. This was the case due to the heterogeneity of classification of both economic sectors as well as occupations.

Therefore, in order to make the resulting ratios applicable to the case of Iran, we took the more detailed data on both sectoral and occupational levels and converted them into more general disaggregated classifications of the Iranian Fifth plan. The equivalences of occupational classifications by the Plan and Budget Organization of Iran (P.B.O.) and minor occupational groupings adopted by the Organization For Economic Co-operation and Development (O.E.C.D.) are

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[1] O.E.C.D., Statistics of the Occupational and Educational Structures of the Labour Force in 53 Countries (Paris: Organization for Economic Co-operation and Development, 1970).

Table VI-21

*List of Countries and the Years of Data
Concerning Composition of Labor Skill

OECD Member Countries

*Belgium	1961	*Netherlands	1960
Canada	1951	*Norway	1960
Canada	1961	Portugal	1960
*Denmark	1960	Sweden	1960
*France	1962	Turkey	1960
*Germany F.R.	1961	Turkey	1965
*Great Britain	1961	United States	1950
Greece	1961	United States	1960
*Ireland	1961	Yugoslavia	1961
Japan	1960		

Non-OECD Member Countries

*Argentina	1960	Mexico	1960
*Chile	1960	Morocco	1960
Costa Rica	1963	Pakistan	1961
Csechoslovakia	1962	Panama	1960
Ecuador	1962	Peru	1961
Egypt	1960	Philippines	1960
El Salvador	1961	*Poland	1964
*Finland	1960	*Puerto Rico	1960
Ghana	1960	*Rumania	1956
Honduras	1961	Sierra Leone	1963
Hong-Kong	1961	South Africa	1960
*Hungary	1960	Syria	1960
India	1961	Thailand	1960
*Israel	1961	Taiwan	1956
Jamaica	1960	Uganda	1962
Jordan	1961	*Uruguay	1963
Korea (S.)	1960	*USSR	1959
Libya	1964	Zambia	1965/66

Source: OECD., p. 10.

Note: Countries which are identified by * have had their per capita income between 500 to 1500 U.S. dollars at the time specified.

shown in Table VI-22. The general grouping of the economic sectors as before are: agriculture, oil, industry and services.[1]

On the basis of the above-mentioned classification of occupations and economic sectors, we summed up the corresponding number of various fractions of labor in each occupation within each economic sector over all the countries wherever data allowed. Then the ratios which are found by dividing the former to the latter are considered as our indicators. These ratios are computed in two ways: (a) over all the 53 countries; (b) over 18 countries which their per capita income at the time have been between 500 and 1500 U.S. dollars.[2]

We have already predicted the size of total labor demand in each sector. Application of the matrices of ratios as per Table VI-23 could hence provide us with some approximate composition of skill demand in Iran as follows:

$$[M] = [M_4]\,[M_3]$$

where: $[M]$ = the predicted demand for skills

$[M_4] = [M_1]/100$, where $[M_1]$ = the matrix of

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[1]See footnotes of Table VI-1 for disaggregated components of each of these general categories.

[2]These countries, which are identified by * in Table VI-22, are thought to have had a closer economic structure at the time to the present situation of the Iranian economy. See O.E.C.D., Further Analyses and Statistical Data (Paris: 1971), p. 108.

Table VI-22

Equivalences of Occupational Classifications by P.B.O. and Minor Occupational Groups Adopted by O.E.C.D.

Code	P.B.O.[1]	Code	O.E.C.D.[2]
1	Engineers	0-0	Architects, engineers and surveyors
2	Medical cadre	0-3 0-4 0-5	Doctors and dentists Nurses and midwives Medical workers
3	Educational cadre	0-6	Teachers
4	Miscellaneous	1	Administrative, executive and managerial workers
5	Skilled and semi-skilled workers	0-1 0-2 0-7 to 0-9	Physical scientists Biologists, veterinarians and agronomists clergy, jurists, artists and writers
6	Technicians	0-X 0-Y	Draughtsmen, and science and eng. technicians ... other professional and technical and related workers

Notes: (1) Aggregated classification of occupations in Iran adopted by Plan and Budget Organization (P.B.O.) in Iran's Fifth Plan (Tehran: Kayhan, 1975), p. 31.

(2) "Classification of minor occupational groups in major groups 0 and 1" based on "International Standard Industrial Classification of All Economic Activities (ISIC)", published by UN in Statistical Paper, Series M, No. 4, Rev. 1 (New York: 1958); and International Standard Classification of Occupations (ISCO) published by The International Labour Office (Geneva: 1962).

Table VI-23

Cross-Sectional Occupational Structure of Humanpower in Various Economic Sectors

(percentage)

Code	Occupations / Economic Sectors	Agriculture		Oil		Industry		Services	
		A	B	A	B	A	B	A	B
1	Engineers	0.02	0.07	41.68	40.50	1.66	1.81	0.81	.72
2	Medical cadre	0.01	0.05	1.72	1.85	0.67	0.72	4.66	5.14
3	Educational cadre	0.24	0.42	21.54	10.21	9.78	9.83	28.26	32.42
4	Miscellaneous	4.57	7.11	10.03	8.16	5.50	6.94	36.50	32.22
5	Skilled and semi-skilled workers	8.66	14.20	12.47	21.20	67.05	55.12	1.47	2.18
6	Technicians	5.06	10.21	2.24	14.36	11.14	21.53	16.30	18.76
7	Unskilled workers	81.44	67.94	10.32	3.72	4.20	4.05	12.00	8.56
	Total	100%	100%	100%	100%	100%	100%	100%	100%

Notes: (1) These findings are based on the data published by O.E.C.D. in <u>Statistics of the Occupational and Educational Structures of the Labour Force in 53 Countries</u> (Paris: 1971).

(2) A's columns consist of ratios based on statistics from observed countries altogether, whereas B's columns consist of ratios based on data from 18 selected countries with economic structures at the time presumably closer to the present situation of the Iranian economy.

cross-sectional occupational structure of humanpower in various economic sectors.

$[M_3] = [M_2]'$, where $[M_2]'$ = the transpose of the matrix composed of the time series predicted demand for sectoral humanpower in Iran from 1973 to 1977.

Applying this operation for each of the two alternative sets of predicted sectoral humanpower (as per Tables VI-19 and VI-20) we found the following four patterns of demand for skills in Iran during the projection period (Tables VI-24 to VI-27).

Prediction of Skill Requirement in Iran

Since there are some skills available at the beginning of each year, therefore, the size of required skill could be measured by subtracting the two corresponding figures, viz: predicted demand minus prospected supply.

For the case of Iran, we had access only to the estimated supply of skills at the end of the Fifth plan for the whole economy.[1] Therefore, in order to derive appropriate policy implications, we have compared the predicted demand for skills and the estimated supply of skills at the end of the Fifth plan to figure out the possible shortages

[1]The data which are officially issued in the Fifth plan are presumably resulted from the summation of skill supply at the end of the Fourth plan and the estimated changes in the supply of skills during the Fifth plan. See Kayhan, Iran's Fifth Plan (Tehran: 1975), p. 31.

Table VI-24

Predicted Demand for Skills in Iran During the Fifth and Sixth Plans (1973-82)

Run I

(1000 Man-Year)

Years / Occupations	Engineers	Medical Cadre	Educational Cadre	Miscellaneous	Skilled & Semi-Skilled	Technicians	Unskilled
1973	91.2521	146.370	1058.45	1315.40	2218.49	936.697	3417.94
1974	98.1305	155.948	1132.48	1389.36	2402.75	992.484	3419.36
1975	105.316	165.016	1204.85	1459.22	2603.39	1048.51	3416.77
1976	112.850	173.578	1275.75	1525.05	2822.15	1105.05	3411.11
1977	120.793	181.714	1345.79	1587.51	3060.91	1162.66	3403.35
1978	129.220	189.546	1415.90	1647.61	3321.75	1222.07	3394.47
1979	138.210	197.212	1487.11	1706.47	3606.92	1284.07	3385.37
1980	147.845	204.848	1560.42	1765.16	3918.85	1349.47	3376.82
1981	158.210	212.572	1636.80	1824.65	4260.21	1419.03	3369.50
1982	169.392	220.490	1717.12	1885.79	4633.86	1493.52	3363.98

Note: Run I is made under the assumption of growth rates for sectoral value added and gross investments adopted from the Fifth plan and application of the skill composition matrix of 53 countries.

Table VI-25

Predicted Demand for Skills in Iran During the Fifth and Sixth Plans (1973-82)

Run II

(1000 Man-Year)

Years / Occupations	Engineers	Medical Cadre	Educational Cadre	Miscel-laneous	Skilled & Semi-Skilled	Techni-cians	Unskilled
1973	94.1449	162.316	1173.21	1330.67	2114.32	1485.49	2824.44
1974	101.242	172.812	1253.91	1400.55	2265.03	1572.34	2824.62
1975	108.694	182.740	1332.37	1467.20	2428.78	1661.48	2821.81
1976	116.549	192.104	1408.72	1530.79	2607.06	1753.51	2816.79
1977	124.869	200.990	1483.67	1591.97	2801.51	1849.33	2810.38
1978	133.732	209.535	1558.23	1651.72	3013.90	1950.07	2803.39
1979	143.219	217.889	1633.51	1711.10	3246.16	2056.94	2796.54
1980	153.416	226.201	1710.66	1771.16	3500.33	2171.20	2790.46
1981	164.412	234.603	1790.69	1832.84	3778.64	2294.10	2785.70
1982	176.299	243.210	1874.56	1896.98	4083.50	2426.87	2782.74

Note: Run II is made under the assumption of growth rates for sectoral value added and gross investments adopted from the Fifth plan and application of the skill composition matrix of 18 selected countries.

Table VI-26

Predicted Demand for Skills in Iran During the Fifth and Sixth Plans (1973-82)

Run III

(1000 Man-Year)

Years \ Occupations	Engineers	Medical Cadre	Educational Cadre	Miscel-laneous	Skilled & Semi-Skilled	Techni-cians	Unskilled
1973	88.2128	141.535	1023.29	1276.46	2149.44	910.228	3387.12
1974	92.0163	147.061	1066.29	1318.13	2258.39	941.899	3369.25
1975	96.0804	152.946	1112.40	1362.89	2376.17	976.168	3356.67
1976	100.415	159.194	1161.05	1410.67	2503.11	1013.04	3348.46
1977	105.033	165.807	1212.91	1461.50	2639.65	1052.56	3343.96
1978	109.947	172.795	1267.88	1515.39	2786.28	1094.78	3342.70
1979	115.172	180.165	1326.07	1572.40	2943.55	1139.81	3344.36
1980	120.725	187.929	1387.59	1632.62	3112.07	1187.74	3348.71
1981	126.624	196.101	1452.59	1696.13	3292.51	1238.69	3355.59
1982	132.888	204.696	1521.21	1763.04	3485.6[illegible]	1292.81	3364.88

Note: Run III is made under the assumption of growth rates for sectoral value added and gross investments adopted from the observed sample and application of the skill composition matrix of 18 selected countries.

Table VI-27

Predicted Demand for Skills in Iran During the Fifth and Sixth Plans (1973-82)

Run IV

(1000 Man-Years)

Years / Occupations	Engineers	Medical Cadre	Educational Cadre	Miscel-laneous	Skilled & Semi-Skilled	Techni-cians	Unskilled
1973	91.0480	156.995	1134.46	1293.66	2055.13	1445.42	2799.57
1974	94.9849	163.041	1181.31	1332.54	2142.54	1494.46	2784.15
1975	99.1981	169.483	1231.33	1374.54	2237.62	1547.79	2773.15
1976	103.698	176.323	1284.56	1419.62	2340.56	1605.42	2765.76
1977	108.498	183.566	1341.05	1467.75	2451.66	1667.43	2761.46
1978	113.611	191.219	1400.90	1518.96	2571.28	1733.94	2759.87
1979	119.054	199.292	1464.23	1573.32	2699.83	1805.09	2760.70
1980	124.845	207.797	1531.16	1630.89	2837.81	1881.09	2763.78
1981	131.003	216.750	1601.83	1691.77	2985.75	1962.16	2768.97
1982	137.549	226.165	1676.40	1756.08	3144.22	2048.54	2776.18

Note: Run IV is made under the assumption of growth rates for sectoral value added and gross investments adopted from the observed sample and application of the skill composition matrix of 18 selected countries.

and/or surpluses of various skills. The results, which could measure the feasibility of the Fifth plan's goals, are depicted in the following tables VI-28 and VI-29.

6. Policy Implications

The major final findings of this work could be briefed as follows:

(a) predicted sectoral as well as economy-wide demand for humanpower in Iran from 1973-82;

(b) expected prospect of skill composition in Iran during 1973-82.

In regard to sectoral demand for humanpower, predictions were made under two alternative sets of assumptions about the growth rates for sectoral value added as well as gross fixed investments. The first alternative, Fifth plan's conceived growth rates, was made mostly to check upon the feasibility of the plan. Since the plan's rates seemed optimistic we applied the corresponding growth rates from the observation sample (1960-72).

The results which are alternatively shown in Tables VI-19 and VI-20 are respectively depicted in the diagrams VI-1 and VI-2. In both cases, there is a clear upward tendency for labor demand in all the sectors except for agriculture. Considering the envisaged growth path of the economy and its pattern of development, which is emphasizing on industrialization, the higher demand for labor in the oil and industry sectors could be justified. In the case of

Table VI-28

The Prospect of Skill Market in Iran at the End of the Fifth Plan (1977)

(100 Man-Year)

Code	Occupations	Supply	Demand Run I	Demand Run II	Demand Run III	Demand Run IV
1	Engineers	104.1	120.8	124.9	105.0	108.5
2	Medical cadre	157.5	181.7	201.0	165.8	183.6
3	Educational cadre	1210.5	1345.8	1483.7	1212.9	1341.1
4	Miscellaneous	1500.9	1587.5	1592.0	1461.5	1467.7
5	Skilled and semi-skilled workers	2298.3	3060.9	2801.5	2639.6	2451.6
6	Technicians	954.8	1162.7	1849.3	1052.6	1667.4
7	Unskilled workers	3937.7	3403.4	2810.4	3344.0	2761.5
	Total	10163.8	10862.8	10862.8	9981.4	9981.4

Notes: (1) Supply figures are adopted from <u>Iran's Fifth Plan</u>, ibid., p. 31.
(2) Demand figures are taken from Tables VI-25 to VI-30.

Table VI-29

The Scope of Skills in Iran at the End of the Fifth Plan (1977)

(1000 Man-Year)

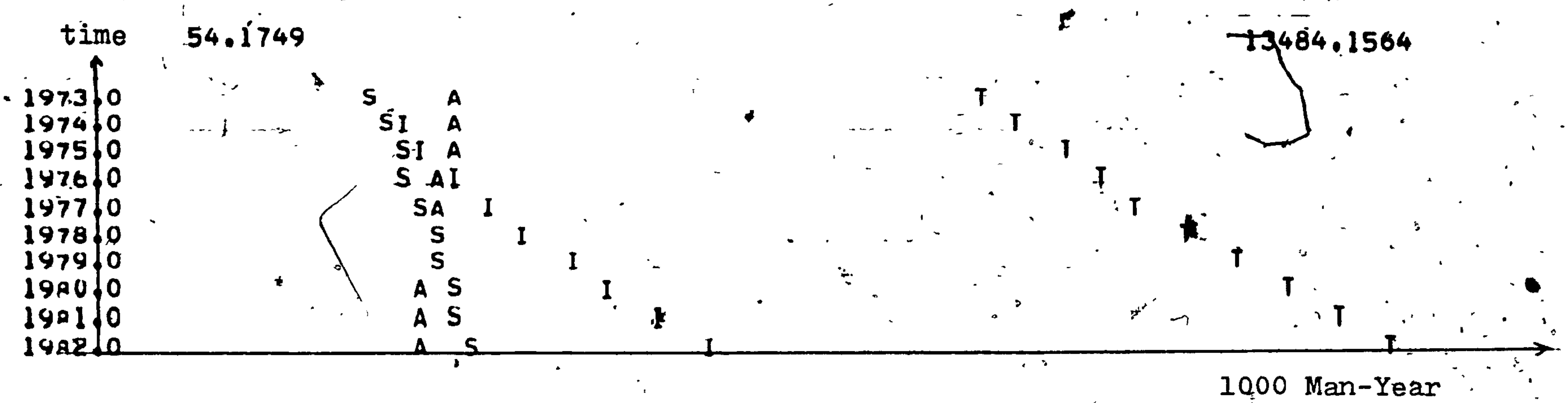
Code	Occupation	Run I	Run II	Run III	Run IV
1	Engineers	-16.7	-20.8	-0.9	-4.4
2	Medical cadre	-24.2	-43.5	-8.3	-26.1
3	Educational cadre	-135.3	-273.2	-2.4	-130.6
4	Miscellaneous	-86.6	-91.1	+39.4	+33.2
5	Skilled and semi-skilled workers	-762.6	-503.2	-341.3	-153.3
6	Technicians	-207.9	-894.5	-97.8	-712.6
7	Unskilled workers	+534.3	+1127.3	+593.7	+1176.2
	Total	-699.0	-699.0	+182.4	+182.4

Notes (1) For underlying assumptions of each run see Tables VI-25 to VI-31.
(2) Skill surplus and shortages are shown respectively by + and - signs.

Figure VI-1

Predicted Sectoral Demand for Humanpower in Iran*
(1973-1982)

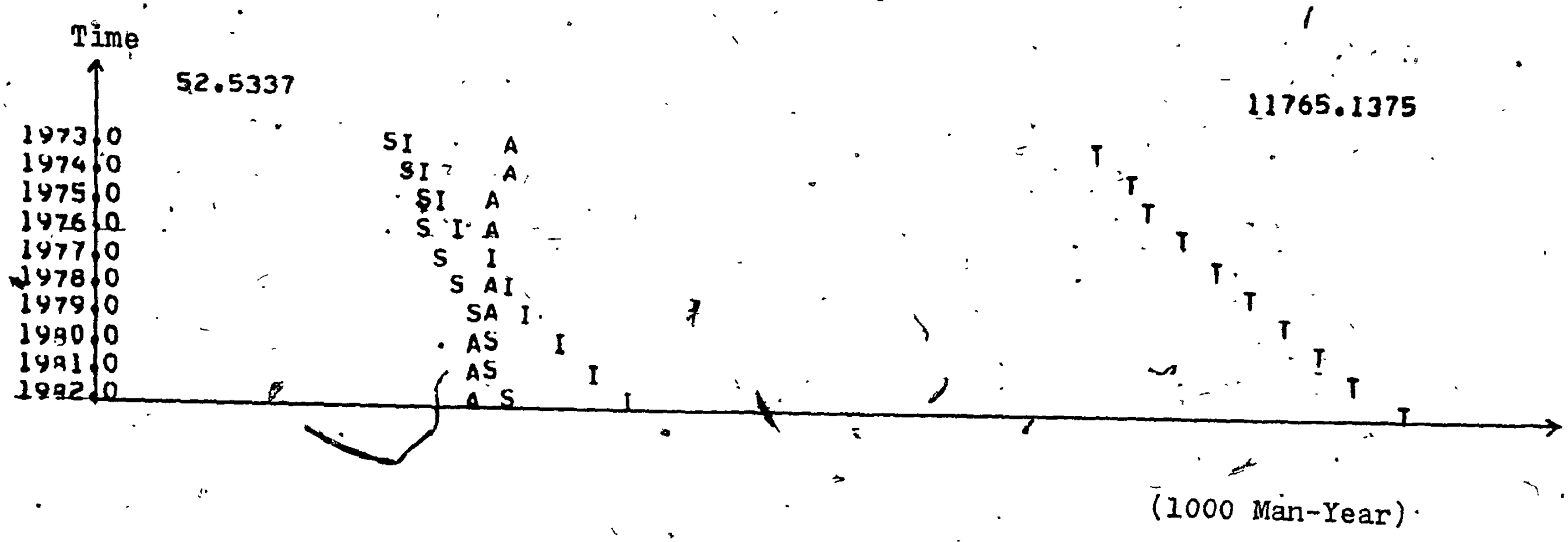
(Alternative I: Adopting Fifth Plan's Growth Rates)



* Demand for labor in each economic sector is figured by the initial letter of that sector as: A=agriculture, O=oil, I=industry, S=services and T=total.

Figure VI-2

Predicted Sectoral Demand for Humanpower in Iran (1973-82)
(Alternative II: Adopting Observed Growth Rates)



Note: Demand for labor in each economic sector is figured by the initial letter of that sector as: A = agriculture, O = oil, I = Industry, S = services and T = total.

the services sector the growing rate of labor demand, though lower than industry, might be reasonable if the skill allocation is appropriate. This will be discussed later on in this section.

However, the declining demand pattern for labor in agriculture, which is mainly due to the past performance of this sector, is unacceptable. This situation creates both social and economic problems. The decline of agricultural activities, which are normally undertaken in the rural areas, causes the migration from there to urban areas. This transition, which has been more than 1.6 million per year during the Fourth plan, creates social discomforts which are mainly caused by urban unemployment, limited capacities of urban facilities and social disorders.[1] On the other hand, the low growth rate of agricultural products, which should feed an increasing population, brings about the shortage of those products and hence, the need to import them from outside. This trend which weakens the power of domestic production (a vicious circle) causes the dependence of the economy on the outside world. Considering that the country has been exporting most of those products up to some years ago, and taking into account the potential capacity of producing the agricultural products with comparative advantage in some respects,

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[1]See Report on the "Employment Policies for Iran During the Fourth Plan and the Fifth Development Plan" (Tehran: Plan and Budget Organization, n.d.), p. 4.

the ever-increasing imports of those products, in the long-run, is hard to justify.[1]

Before turning to other findings of our model, as a note of policy with regard to agriculture, we should examine our two instrumental macro-variables: capital and labor. We have no access to the sectoral capital stock in Iran. However, based on our generated proxies, it could be mentioned that the level of capital stock in agriculture has been much lower than any other sector in the past. The relatively higher growth rate of capital formation during the observation period has not been high enough to cope with capital bottleneck in agriculture. This situation probably has led the planners of the Fifth plan to consider a rate for investment in agriculture much higher than before (29.7% as compared with 12%). This rate which is still lower than the conceived growth rates of investment in oil and service sectors (respectively 50.8% and 39.1%) but higher than the corresponding rate in industry (14.9%) could remedy the shortage of capital in agriculture. But, considering the sector which is too labor intensive, the decrease in agricultural labor force seems very striking. Material welfare could be considered as a major cause for migration of peasants from their rural homes to urban streets. To alleviate this problem, a fair allocation of services could be

[1]See "Foreign Trade Statistics of Iran" (Tehran: Ministry of Finance and Economic Affairs, Annual Report).

helpful. In which case, higher growth rate of investment in services might be justifiable.

With respect to the expected skill composition during the projection period (1973-82), we translated both alternatives of the predicted sectoral demand for humanpower into the skill requirements of the economy during that period. In so doing, as a second best approach, we applied some international skill composition matrices. These matrices are built on the statistics respectively from a set of 53 countries and a sub-set of 18 selected countries. The results which are shown in Tables VI-24 to VI-27 are also depicted in figures VI-3 to VI-6. A glance at these four diagrams indicate:

i) an ever-increasing demand for all types of skills (1, 2, 3, 4, 5 and 6).

ii) An almost decreasing demand for unskilled workers (7).

iii) A more increasing demand for occupations number 5 (skilled and semi-skilled workers) both in relative as well as absolute terms.

iv) A demand pattern for occupation number 6 above occupations 1 and 2 and below 3, 4, 5 and 7 in diagrams VI-3 and VI-5, but only below 5 and 7 in the other two diagrams.

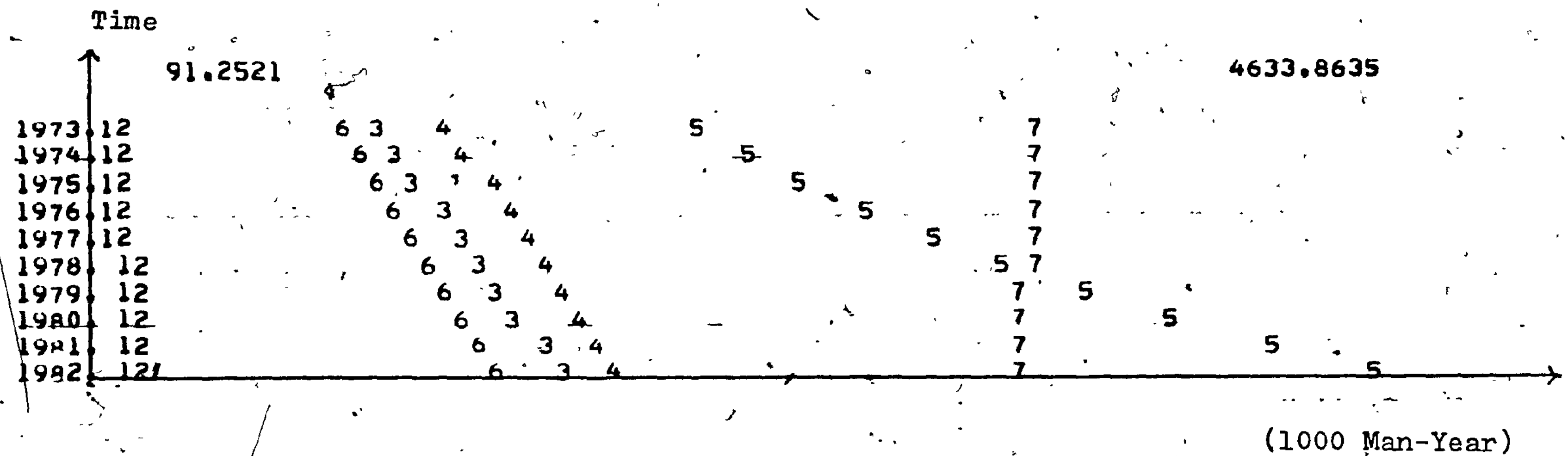
These results could be interpreted as follows:

i) the ever increasing demand for all types of skills is mainly due to the development pattern of the economy. The emphasis on industrialization which has been a prime goal of the recent plans naturally requires a great amount of skilled

Figure VI-3

Predicted Sectoral Demand for Skills in Iran (1973-82)*

(Run I: Adopting Fifth Plan's Growth Rate and 53 Countries Skill Composition Matrix)

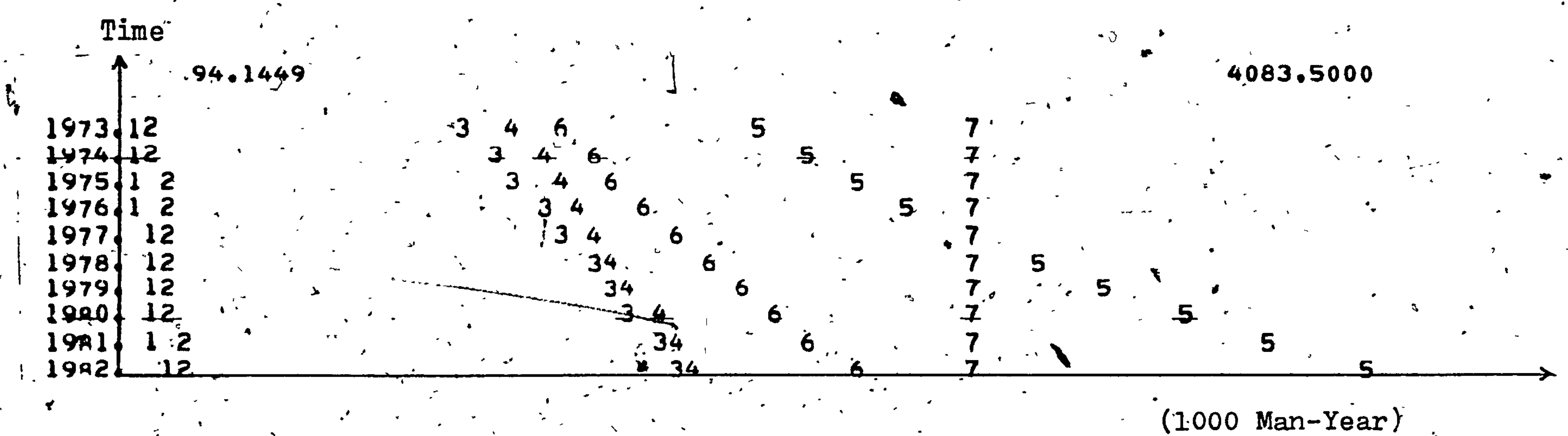


*Demand for skills are figured by their corresponding code numbers as follows: 1 = engineering, 2 = medical cadre, 3 = educational cadre, 4 = miscellaneous, 5 = skilled and semi-skilled workers, 6 = technicians and 7 = unskilled workers.

Figure VI-4

Predicted Sectoral Demand for Skills in Iran (1973-82)*

(Run II: Adopting Fifth Plan's Growth Rates and 18 Selected Countries Skill Composition Matrix)

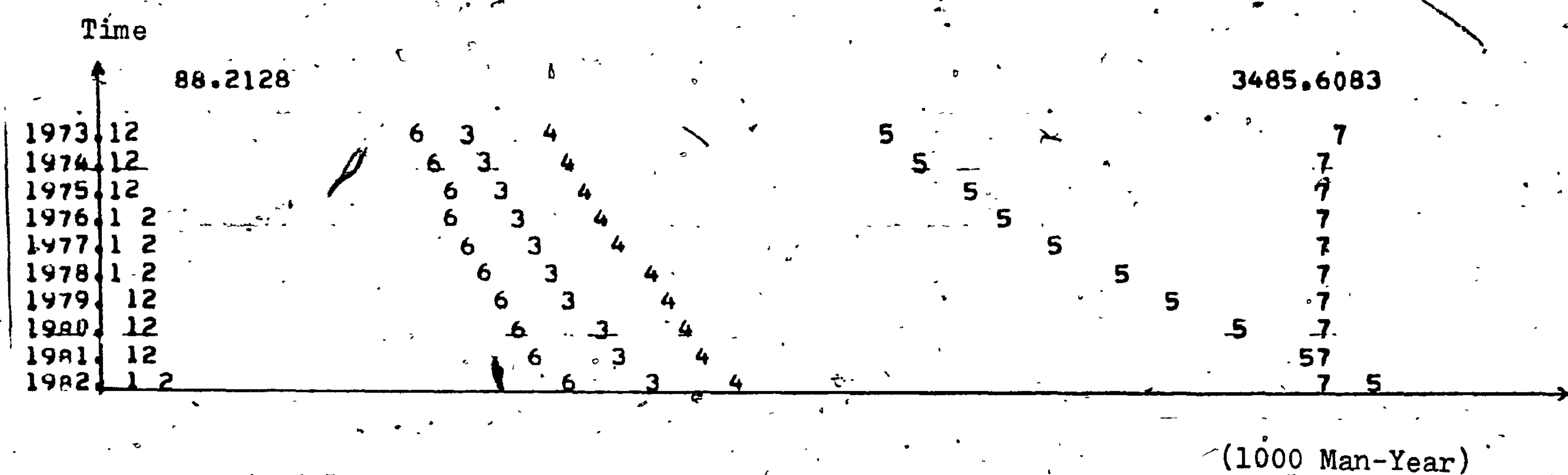


* Demand for skills are figured by their corresponding code numbers as follows:
1 = engineering, 2 = medical cadre, 3 = educational cadre, 4 = miscellaneous,
5 = skilled and semi-skilled workers, 6 = technicians and 7 = unskilled workers.

Figure VI-5

Predicted Sectoral Demand for Skills in Iran (1973-82)*

(Run III: Adopting Observed Growth Rates and 53 Countries' Skill Composition Matrix)

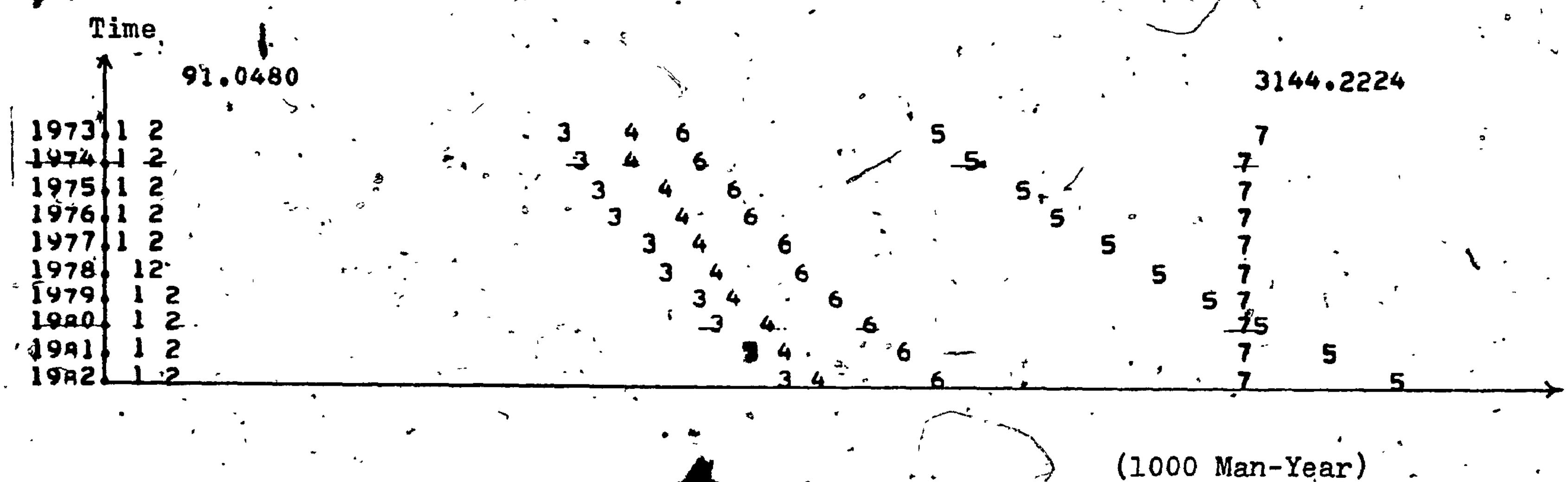


* Demand for skills are figured by their corresponding code numbers as follows:
1 = engineering, 2 = medical cadre, 3 = educational cadre, 4 = miscellaneous,
5 = skilled and semi-skilled workers, 6 = technicians and 7 = unskilled workers.

Figure VI-6

Predicted Sectoral Demand for Skills in Iran (1973-82)*

(Run IV: Adopting Observed Growth Rates and 18 Selected Countries Skill Composition Matrix)



* Demand for skills are figured by their corresponding code numbers as follows: 1 = engineering, 2 = medical cadre, 3 = educational cadre, 4 = miscellaneous, 5 = skilled and semi-skilled workers, 6 = technicians and 7 = unskilled workers.

and semi-skilled workers, engineers and technicians; ii) the decline in demand pattern of unskilled workers is mostly caused by accentuating industrialization at the cost of agriculture. This coincidence of increasing demand for skills on one hand and decreasing demand for unskilled workers on the other hand in Iran could well replace the so-called theory of "labor-surplus economy" with our theory of "skill-scarce economy."[1]

iii) The higher demand for semi-skilled and skilled workers (occupation 5) both in relative and absolute terms indicates the primary phase of industrialization. The young industry which is mostly light and of small-scale, before anything else, requires a large number of medium-level professionals. As industry develops, the number of these professionals will be increased by a higher demand for technicians as well. This is implied by diagrams VI-4 and VI-6 where the transformation matrix for skills is built up on the information from relatively more industrialized set of countries.

To sum up all the above findings about the predicted demand for skills, in the face of no drastic change in their

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[1]The theory of "labor surplus-economy" implies that in LDC's, labor is abundant and hence the only limiting factor to their economic growth is capital. For more details, see John C. H. Fei and Gustav Ranis, Development of the Labor Surplus Economy: Theory and Policy (Homewood, Ill.: Richard D. Irwin Inc., 1964).

pattern of supply, the shortage of skills would be striking. This is a serious constraint to the envisaged economic growth of Iran. In order to attain the assumed growth rates of GDP in both Fifth and Sixth plans, Iran has to overcome the problem of skill shortage. The policy of importing skills from outside could be a short-run remedy but by no means a long-run solution. Should there be a concern in this regard, the improvement of domestic training and educational institutes, both from the quantity and quality points of view, could be effective from the supply side. On the demand side, which is at least as important as the supply side, are the people who should seek the skills. This search could be directed towards the line of growth requirements only through motivation. A notion of most significance and least concern in almost all LDC's.

Concluding Remarks

At this stage we should admit that our work, though it supplies some finished products, is not a final product per se. Fortunately, the response to the question of whether our approach has proved to be helpful and hopeful in enhancing the purpose of "planning the strategic growth agents in the process of development" is positive. It has proved to be not only a helpful framework for implicating policy issues, but also, a hopeful beginning towards future evolution.

In this final section we conclude with some points about the major strengths and weaknesses of our approach and some suggestions for overcoming the latter and building on the former. With regard to the strengths of our approach we can claim the following credits:

a) Planning under the condition of data limitation: as mentioned before at different points of this work, the lack of reliable and sufficient data is the main problem a planner is faced with in almost all the less developed countries. Nonetheless, due to the urgent need of planning the economic development in those areas, a planner cannot and should not wait until data are improved. We have claimed that the improvement in techniques of planning could alleviate the planner's main problem and our view about the present approach is that it has proved to be just that.

b) Disaggregated vs. Aggregated Approach: A major flaw in most of the works concerning the economic planning in LDC's, as mentioned in the text, is aggregation in their approach. For instance, treating all types of labor and capital the same way while we know they are not homogeneous. With respect to humanpower planning in Iran, as far as data allowed, we have made our approach with two stages of disaggregation: (i) four economic sectors and (ii) seven occupational categories. These steps have proved to be useful in avoiding the specification problem. This could be seen by comparing the results of our disaggregated approach and its

[1]Regional disaggregation was not appealing due to localization of industries in the central area and oil in the south.

aggregated alternative, as are shown in the following diagram (figures VI-7 and VI-8 based on Tables VI-19 and VI-20 respectively).

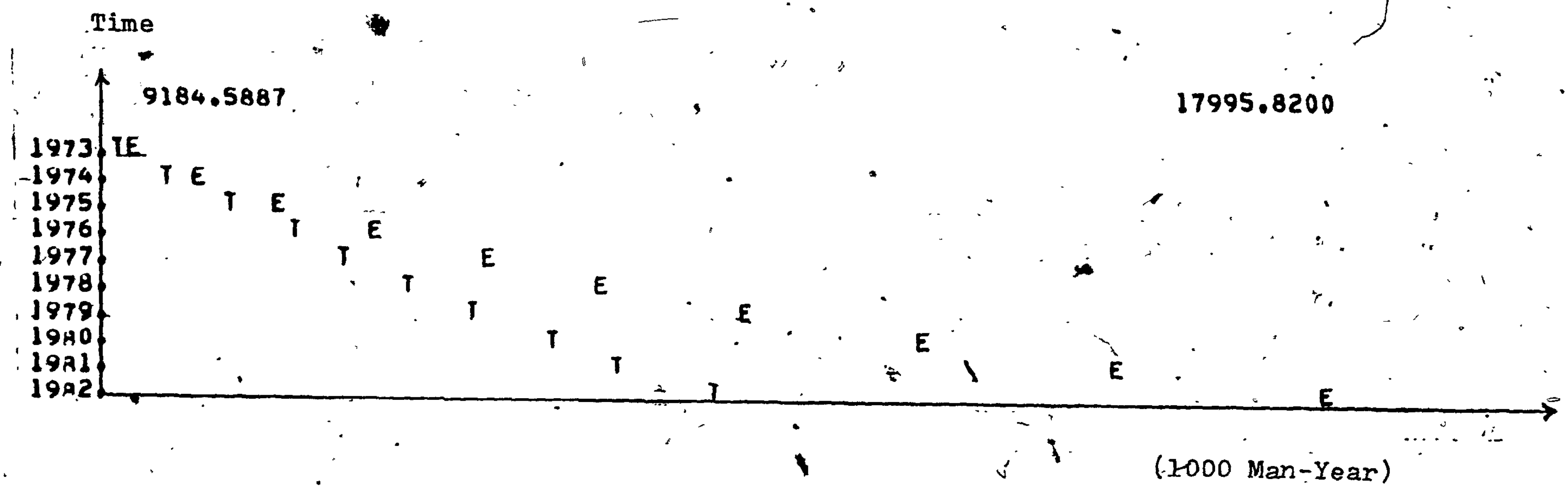
The over-explosion of the economy-wide predicted demand (E), especially in the first alternative, is due to the fact that on the one hand, observations of any aggregate approach are less close to each other than the ones in a corresponding disaggregated approach. On the other hand, logarithmic operation causes biases which are of greater effects on larger amounts.

c) Externalities of the approach: the model through its production functions could be linked to the overall plan of the economy. This is an odd characteristic of this approach in comparison with the previous approaches in humanpower planning wherein no production function is specified. Another vintage benefit of our approach is its applicability to planning the skill demand determined either by occupations of the labor force or by their educational qualifications or by both. This flexibility permits the model to be useful not only for the purpose of humanpower planning but also to be helpful as a guide for educational planning.

At the end we should admit the possible weaknesses of our approach. These drawbacks, as usual, underly mainly in the assumptions of the model. Therefore, to test the credibility of our model, as in the case of any other model, we should examine the validity of its specific assumptions.

Figure VI-7

Predicted Demand for Humanpower: Total Sectoral and Economy's Aggregated*
(Alternative I: Adopting Fifth Plan's Growth Rates)

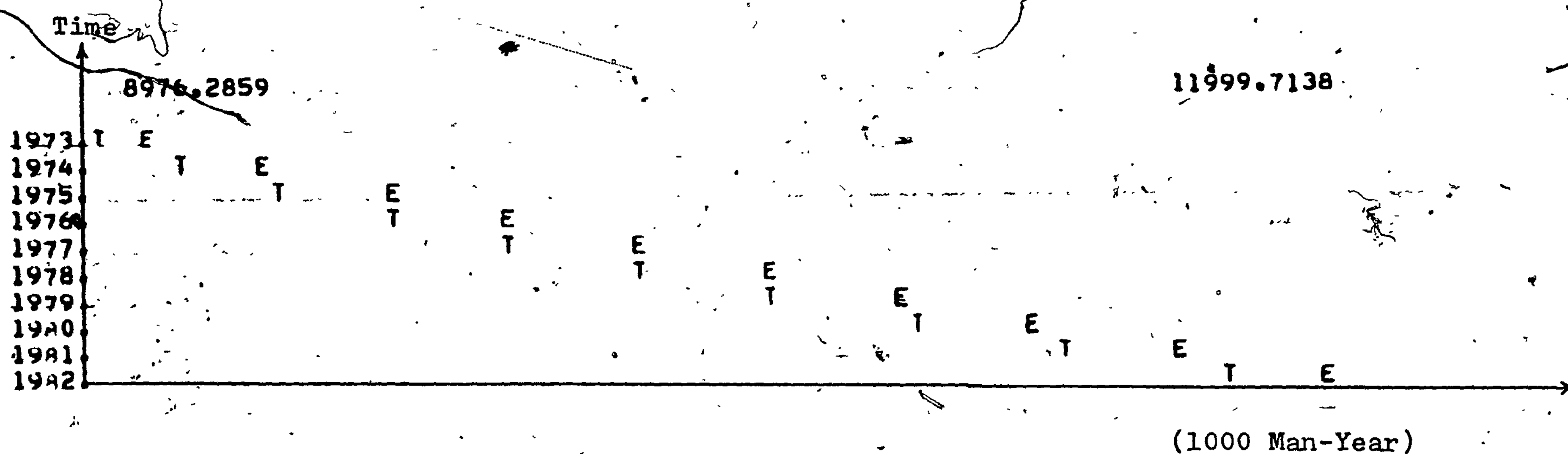


* Prospect pattern of demand for humanpower are depicted by T and E. They respectively stand for total labor demand as a summation of predicted sectoral demand for labor and economy-wide demand as predicted on the basis of aggregate alternative approach.

Figure VI-8

Predicted Demand for Humanpower: Total Sectoral and Economy's Aggregated*

(Alternative II: Adopting Observed Growth Rates)



*Prospect pattern of demand for humanpower are depicted by T and E. They respectively stand for total labor demand as a summation of predicted sectoral demand for labor and economy-wide demand as predicted on the basis of aggregate alternative approach.

In the text we justified the assumptions whenever made. However, in what follows, we will comment a little more on some major assumptions of our model.

a) Cobb-Douglas Production Function: after examining some types of production functions available in the literature, we adopted a general form of the Cobb-Douglas function for our sectoral as well as economy-wide production functions. This choice which was made on the basis of our knowledge of economic theory and was confirmed by our practice of econometrics, though looks acceptable, may not be the best. However, with the limited available information, we had to start with the status quo.

b) Derived-Demand For Humanpower: demand functions for factor inputs are usually built on the basis of cost minimization theory. In doing so, in addition to other things, we are in need of sufficient data for wage rates, capital stock and rental rates. For the case of labor demand in Iran, to the best of our knowledge, there existed no reliable data in these regards. Therefore, we had to follow the second best approach. This was done by deriving sectoral labor demand-type functions from sectoral production functions. This approach might not be advisable in the presence of detailed statistics as mentioned earlier.

c) Skill Composition: in addition to the assumptions about the classification of skills, in order to design the pattern of demand for skills in Iran, we had to apply some matrices built on cross-sectional data on skill structure. Following this line we built two matrices on statistics from a set of 53 countries and a sub-set of 18 countries with their per capita income, at the time, closer to Iran's present level of per capita income. This is again, though a second best alternative, by no means an ideal one.

d) Projection Assumptions: in order to project the demand for various humanpower on the basis of functions we derived from production functions, we had to project the values of variables exogenous to our projecting functions, i.e. value added and capital. We have taken the supply capacity of economic sectors in projecting years as exogenous. Moreover, we have found the sizes of sectoral value added through extrapolation by considering two sets of growth rates: Fifth plan's as well as observed growth rates. However, we have not justified our quantitative estimates of supply capacities in any detail. Rather, we have simply assumed that they are likely to be so. A more comprehensive analysis would have to look more carefully into factor inputs as well as technology.

With regard to technology, we have assumed it to be constant. This assumption, though might be acceptable in the short-run, could not be justified in the long-run. With respect to factor inputs, we have followed the tradition by considering labor and capital. However, neither of these two factors is well documented in Iran. For example, from the capital point of view, we did not have any data on capital stock, therefore, we had to develop a model for generating the capital stock endogenously. This approximation process, though interesting, might not be comparable with the facts that could be gained from real data.

All in all, we can sum up the possible weaknesses of our approach to underly the assumptions of its model. Assumptions are usually made to frame unknown realities. Therefore, we come to the root of the problem, viz. data. In Iran, as in most of the other LDC's, a planner has to start with the data rather than the model. Naturally, one must have some idea about the type of model(s) to be applied in designing a data framework, but in the final analysis, this is the data which dictates the framework of the model.[1]

[1]Analysis of our statistical sources of information as well as some recommendation for improvement of the data in Iran are made in Appendix B.

APPENDICES

APPENDIX A

Aggregation of Humanpowers

Due to the importance of the humanpower aggregation in any production approach to the causes of growth, some methods of humanpower aggregation will be reviewed briefly hereunder. This will help us to evaluate the works that have been done so far in this respect as well as to establish some up-to-date foundation for further approaches.

1. Labor Aggregation assuming $e_{ij} = \infty$: The assumption of infinite elasticity of substitution especially between most educated people, as was mentioned already, initiated mainly by Denison as his findings showed an almost infinite elasticity of substitution between educated labors. However, through generalizing this assumption the following format could represent the humanpower aggregation:

$$L^{\infty} = \sum L_i W_i \qquad i = 1 \ldots n \tag{1}$$

where: L^{∞} = aggregate supply of labor inputs $(L_1, \ldots L_n)$ with $e_{ij} = \infty$

W_i = the ratio of earnings of labor type i to the earnings of a given type of labor such as 1.

Therefore, equation (1) could be expanded as:

$$L^{\infty} = L_1 + L_2 \frac{W_2}{W_1} + \ldots\ldots + L_n \frac{W_n}{W_1} \tag{2}$$

Note that the relative earnings are assumed to reflect relative marginal products. Therefore, by considering the relative earnings for a given year and measuring the changes in the supply of labor force over a period of time, we are implicitly assuming that the elasticity of substitution between labor inputs is infinity.

2. Labor Aggregation assuming $e_{ij} = 1$: The elasticity of substitution equal to one could be interpreted as a one per-cent change in relative earnings could cause a one per-cent change in the ratio of associated labor inputs. In such a case, the labor inputs could be aggregated according to the following equation:

$$L^1 = \prod_{i=1}^{n} L_i^{\beta_i} \qquad i = 1 \ldots n \tag{3}$$

where: β_i is the L_i's fixed earning share of total earning (W). Equation (3) could be expanded as:

$$L^1 = L_1^{\beta_1} . L_2^{\beta_2} . \ldots\ldots L_n^{\beta n} \tag{4}$$

such that: $\Sigma\beta_i = 1$

3. Labor Aggregation assuming e_{ij} to be constant and equal for each pair of labor type: Constant elasticity of substitution (CES) is a widely adopted assumption about factor inputs in production functions.[1] Considering this assumption for the labor inputs, it is possible to aggregate n different

[1]See for instance V. Corbo and A. V. Peeterssen, "Production Functions in Canadian Manufacturing: Some Preliminary Results", Concordia University, Working Paper No. 1974-11, Montreal 1974.

types of labor inputs as follows:[1]

$$L^c = (\Sigma d_i L_i^{-u})^{-\frac{1}{u}} \qquad i = 1 \cdots n \qquad (5)$$

where: L^c = aggregated labor inputs with constant elasticity of substitution

d_i & u = estimated parameters such that: $\Sigma d_i = 1$

and $e_{ij} = \frac{1}{1-u}$ = constant for all i's and j's.

In order to estimate the function (5) we assume that relative marginal products to be equal to the relative factor prices. Therefore we can write:[2]

$$\frac{W_i}{W_j} = \frac{d_i}{d_j} \left(\frac{L_i}{L_j}\right)^{-\frac{1}{e_{ij}}} \qquad (6)$$

Having the information about relative earnings and quantities of the labor inputs makes the estimation of (6) possible.

4. Labor Aggregation assuming e_{ij} to have its exact estimated value

As it is explicit in the fundamental assumption of aggregation type (3), the elasticities of substitution between any pair of labor are constant and equal. This might not be the case in the real world. As Bowles has recognized: "The

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[1]A similar version of this function is suggested in H. Uzawa, "Production Functions with Constant Elasticities of Substitution," Review of Economic Studies 29 (1962): 291-99.

[2]For elaborations on estimating C.E.S. functions, see V. Corbo, "An Interactive Procedure to Calculate the Least Squares Estimates for a C.E.S. Function: Some Small Sample Properties," Concordia University, Montreal 1974a (mimeo.).

sizable differences in the estimated coefficients suggested that there would be some loss in assuming all elasticities to be the same."[1] That is why he adopted an extension of Sato's (1967) two-level C.E.S. function, through which the exact values of elasticities of substitution between each pair of manpower types could be incorporated. This aggregation could be shown as follows:[2]

$$L^* = h(L_1, L') \qquad (7)$$

and

$$L' = g(L_2, L_3) = (g_2 L_2^{-k} + g_3 L_3^{-k})^{-\frac{1}{k}} \qquad (8)$$

where: g_2 & g_3 are the average relative earnings of the types of labor such that $g_2+g_3 = 1$

and $e_{ij} = \frac{1}{1+k}$

Therefore, the final form of estimating aggregated manpower in this way is:

$$L^* = h\left[L_1, (g_2 L_2^{-k} + g_3 L_3^{-k})^{-\frac{1}{k}}\right] \qquad (9)$$

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[1]S. Bowles, p. 78, footnote 12.

[2]This is based on Bowles' finding that there is a low elasticity of substitution between first-level educated and other levels of manpower, while the elasticity of substitution between manpowers with the second and third levels of schooling is relatively high, p.74.

APPENDIX B

Analysis of the Statistical Sources of Information

Information about the sectoral value added, gross fixed investment and humanpower over the period 1960-72 are adopted from official statistics provided by the Central Bank of Iran. The corresponding growth rates of sectoral value added for the prediction purposes (1973-1982) have been built up from information supplied by the Plan and Budget Organization. Since both of the above institutions are among the most reliable official sources of information, in the first instance, we have accepted the reliability of their issued data for the purpose of our approach.

However, the validity of conclusions reached from the operation of our models are closely related to the accuracy of the data. In this appendix, therefore, we shall assess the statistics which is applied in the present work. Accordingly, we make some recommendations for the improvement of the available data and collection of new types of data.

<u>Value Added in Agricultural Sector</u>: the average annual growth rate of the value added in the agricultural sector for the period 1960-72 is put at 3.5 per cent.[1]

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[1] Table VI-11, p. 183.

This rate which is higher than the growth rate of population (2.9 per cent) seems overestimated if we view the situation from other angles.

There is evidence to show that per capita consumption of food has actually declined over the observation period. At the same time, agricultural imports doubled while agricultural exports increased much less than that.[1] This implies that the actual growth rate of value added in the agricultural sector should be much less than 3.5 per cent. By the same token, the average annual growth rate of 7 per cent envisaged for agriculture during the Fifth plan seems too optimistic.

Value Added in the Oil Sector: there is no available evidence to check the validity of 15.1 per cent average annual growth rate for value added of oil during the observation period. Intuitively, however, it seems reasonable. But the 51.5 per cent annual average growth rate for oil at constant prices during the Fifth plan looks overexaggerated.

Value Added in Industry: the annual average growth rate of value added in industry over the period 1960-72 is set by the Central Bank at 12.4 per cent. In addition to the Central Bank, the Ministry of Economy performs industry surveys which their figures are not always comparable to the Bank's provisional value added.

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[1] I.L.O., ibid., Pyatt, p. 36.

As a reason for the above inconsistency we can mention the different ways in which those organizations collect their data. Bank's data are collected from a selection of large modern industries while the Ministry's data are based on surveys of large industrial establishments (with more than 10 employees) and a five per cent sample of small-scale urban industrial establishments. In addition to the response errors, it seems that the small-scale manufacturies, a large component of the industrial sector in Iran which is growing at a significantly lower rate than large-scale manufacturies, are not given a proper weight.

Since Central Bank usually adjusts its figures with the Ministry's data, therefore, it could be argued that: (a) figures for value added in industry understate the contribution of industry to the GNP; (b) the actual growth rates of value added in industry are probably lower than the official figures.

Value Added in Services: the annual average growth rate of value added in services is usually computed by the Central Bank on the basis of growth rates of agriculture and industry. Therefore, lower growth rates in these two sectors imply lower growth rates for services. Based on the above assessments of growth rates of agriculture and industry, it could be commented that growth rates of services over the observation period 1960-72 (10.6 per cent) as well as the corresponding rate envisaged in the Fifth plan (16.4 per cent) are overstated.

Capital Stock and Fixed Investment: in Iran, as is the case for most of the other countries, there is no data for capital stock. For the purpose of our model, therefore, we approximated sectoral capital stocks by generating them through sectoral fixed investments.[1] We built up the data for gross investment from information provided by the Central Bank for the period 1960-72. There are evidences, however, to show that the Bank's figures in this regard are understated. This is because:

(a) markups on imported capital goods for trade, distribution and installation are too low according to international standards.

(b) Capital formation in traditional goods are not taken into account.

Given appropriate adjustments, the level of sectoral fixed investment would be much higher than the figures provided by the Bank. It follows that the contribution of fixed capital formation to GNP, as well as the incremental capital output ratios will increase well above the level given by the Bank.

It is also important to note that the Central Bank makes no estimates of investment in stocks and considers arbitrarily a 7 per cent annual growth rate uniquely for all

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[1]See pp. 170-178.

the sectors. However, for the purpose of generating sectoral capital stock from gross investments, we followed an international tradition by assuming a 5 per cent depreciation for all the sectors except for oil wherein the corresponding rate is assumed to be 10 per cent. These rates, which are still somehow arbitrary, seem more realistic than a unique rate for all the sectors.

For the purpose of generating sectoral capital stocks over the projection period, we had access only to the sectoral investments for the whole Fifth plan at current prices and not to the yearly figures at constant prices. Therefore, we had to follow an approximation procedure which is explained in the text.[1] To do so, we adopted the annual average growth rate for total gross fixed investment of 29.7 per cent at constant prices of 1972. This rate, which is envisaged in the Fifth plan, seems very optimistic especially for the Sixth plan.

Humanpower: information about the humanpower in Iran is collected by various agencies. This information is both inadequate and inconsistent. There are cases where the data produced by the same agency are not compatible. For the purpose of our model, the only series of consistent information that we could obtain in this regard was the statistics provided by the Central Bank for active population in the

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[1]See pp. 184-192.

main economic groups over the period 1960-72.

There was no systematic information available for the wage rates as well as the skill composition of the labor force. Therefore, we had to follow a second-best approach in both deriving labor demand equations and finding its skill composition. Suppose these alternatives are acceptable, probably it is still misleading to analyze shortages and surpluses of various labor without having a good knowledge of its corresponding market. In other words, if the economy operates under the competitive conditions, the shortages and surpluses of labor could be traced by studying the changes occurring in their relative wage rates. This information, which was not available to us, provides only a part of the data needed for forming a skill development strategy. The other part consists of information about the cost of providing skills. For it is not economical to produce a skill whose social costs outweigh the social benefits to be derived from it.

Finally, in order to establish a skill priority framework in the light of economic needs, very long and detailed information on the sectoral, educational and occupational distribution of the labor force is necessary. So far, Iran has only two population censuses. The most recent sectoral, occupational and educational information about the skill force in Iran is that of 1966 census which is of a minimal value for a rapidly changing economy. Another general census performed by the statistical center of Iran will be soon available. This will be very helpful for any planning exercise.

The Population and Manpower Bureau of the Plan and Budget Organization, Minister of Labor and Social Affairs, as well as some other official and non-official persons are in the work of humanpower forecasting. Unfortunately, the forecasts made by various agencies are mostly incomparable. Therefore, it seems of urgent necessity that a very well established agency take the responsibility of humanpower forecasting. In this way, the waste of resources due to duplication of works will be avoided. At the same time, the forecasting agency could adopt a methodology which enables universal comparability.

APPENDIX C

Statistical Annex

In this appendix detailed information about the generated sectoral capital stocks, both for observation period (1960-72) and projection period (1973-82), are tabulated. Each table covers the following information for each economic sector: Gross Investment (I_j), Capital Stock (K_j), Net Investment (NI_j) and Replacement (REP_j).

Computations are made according to our model developed for generating capital, i.e.:

$$K_t^j = (1-d^j)^t K_o^j + \sum_{n=1}^{t} (1 - d^j)^{t-n} \cdot I_{n-1}^j \qquad j = 1, 2 - 4$$

where: K_t = capital stock at the beginning of the period t
K_o = initial amount of capital stock
d = depreciation rate
I = gross investment
and j's = economic sectors.

A five per cent depreciation rate is assumed for all the sectors except for oil wherein the corresponding rate is assumed to be ten per cent. The sectoral initial capital stocks are also approximated by optimizing the non-linear estimations of sectoral production functions. The final choice of capital stock was made after some sensitivity analysis.[1]

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[1] See pp. 170-178.

With regard to gross investment, we could build up a time-series over the observation period, from the information provided by the Central Bank of Iran.[1] For the projection period, however, the corresponding figures are projected under two alternative sets of sectoral growth rates for gross investment: (1) Fifth plan's conceived rates, and (2) observed computed rates.[2]

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[1]National Income of Iran (1959-78), Bank Markazi Iran (Tehran: 1972).

[2]See p. 188.

Table C-1

Gross Investment (I1), Capital Stock (K1), Net Investment (NI1) and Replacement (REP1) of the Agriculture Sector (1960-72)

(Billion rials: at Constant Prices of 1960)

Years Variables	I1	K1	NI1	REP1
1960	3.70000	0.	3.70000	0.
1961	3.80000	3.70000	3.61500	.185000
1962	3.90000	7.31500	3.53425	.365750
1963	3.50000	10.8493	2.95754	.542463
1964	3.90000	13.8068	3.20966	690339
1965	4.40000	17.0164	3.54918	850822
1966	5.50000	20.5656	4.47172	1.02828
1967	5.20000	25.0373	3.94813	1.25187
1968	7.90000	28.9855	6.45073	1.44927
1969	7.90000	35.4362	6.12819	1.77181
1970	8.90000	41.5644	6.82178	2.07822
1971	9.00000	48.3862	6.58069	2.41931
1972	14.4000	54.9669	11.6517	2.74834

Table C-2

Gross Investment (I2), Capital Stock (K2), Net Investment (NI2) and Replacement (REP2) of the Oil Sector (1960-72)

(Billion rials: at Constant Prices of 1960)

Years	I2	K2	N12	REP2
1960	4.70000	0.	4.70000	0.
1961	5.00000	4.70000	4.53000	.470000
1962	5.00000	9.23000	4.07700	.923000
1963	4.40000	13.3070	3.06930	1.33070
1964	5.00000	16.3763	3.36237	1.63763
1965	5.70000	19.7387	3.72613	1.97387
1966	9.60000	23.4648	7.25352	2.34648
1967	7.30000	30.7183	4.22817	3.07183
1968	11.1000	34.9465	7.60535	3.49465
1969	12.8000	42.5518	8.54482	4.25518
1970	12.2000	51.0967	7.09033	5.10967
1971	8.90000	58.1870	3.08130	5.81870
1972	13.6000	61.2683	7.47317	6.12683

Table C-3

Gross Investment (I_3), Capital Stock (K_3), Net Investment (NI_3) and Replacement (REP3) of the Industry Sector (1960-72)

(Billion rials: at Constant Prices of 1960)

Years / Variables	I3	K3	N12	REP3
1960	26.4000	113.140	20.7430	5.65700
1961	27.7000	133.883	21,0059	6.69415
1962	27.5000	154.889	19.7556	7.74444
1963	24.7000	174.644	15.9678	8.73222
1964	27.6000	190.612	18.0694	9.53061
1965	31.6000	208.682	21.1659	10.4341
1966	43.3000	229.847	31.8076	11.4924
1967	48.0000	261.655	34.9172	13.0828
1968	57.9000	296.572	43.0714	14.8286
1969	65.5000	339.644	48.5178	16.9822
1970	67.6000	388.162	48.1919	19.4081
1971	72.5000	436.353	50.6823	21.8177
1972	85.5000	487.036	61.1482	24.3518

Table C-4

Gross Investment (I_4), Capital Stock (K_4), Net Investment (NI_4) and Replacement (REP4) of the Services Sector (1960-72)

(Billion rials: at Constant Prices of 1960)

Years / Variables	I4	K4	N14	REP4
1960	17.9000	130.200	11.3900	6.51000
1961	18.9000	141.590	11.8205	7.07950
1962	18.7000	153.411	11.0295	7.67052
1963	16.8000	164.440	8.57800	8.22200
1964	18.8000	173.018	10.1491	8.65090
1965	21.5000	183.167	12.3416	9.15835
1966	26.2000	195.509	16.4246	9.77544
1967	27.5000	211.933	16.9033	10.5967
1968	36.2000	228.837	24.7582	11.4418
1969	40.1000	253.595	27.4203	12.6797
1970	43.1000	281.015	29.0492	14.0508
1971	49.3000	310.064	33.7968	15.5032
1972	65.8000	343.861	48.6069	17.1931

Table C-5

Projected Gross Investment (I1), Capital Stock (K1), Net Investment (NI1) and Replacement (REP1) of the Agriculture Sector (1973-82)

(Alternative I: Projection Under the Fifth Plan's Conceived Investment Growth Rates)

(Billion rials: at Constant Prices of 1960)

Years	Variables I1	K1	NI1	REP1
1973	18.6768	66.6185	15.3459	3.33093
1974	24.2238	81.9644	20.1256	4.09822
1975	31.4183	102.090	26.3138	5.10450
1976	40.7495	128.404	34.3293	6.42019
1977	52.8521	162.733	44.7155	8.13665
1978	68.5492	207.449	58.1768	10.3724
1979	88.9083	265.625	75.6270	13.2813
1980	115.314	341.252	98.2515	17.0626
1981	149.562	439.504	127.587	21.9752
1982	193.982	567.091	165.628	28.3545

Table C-6

Projected Gross Investment (I2), Capital Stock (K2) Net Investment (NI2) and Replacement (REP2) of the Oil Sector (1973-82)

(Alternative I: Projection Under the Fifth Plan's Conceived Investment Growth Rates)

(Billion rials: at Constant Prices of 1960)

Years \ Variables	I2	K2	NI2	REP2
1973	20.5088	68.7415	13.6347	6.87415
1974	30.9273	82.3761	22.6897	8.23761
1975	46.6383	105.066	36.1317	10.5066
1976	70.3306	141.198	56.2108	14.1198
1977	106.059	197.408	86.3177	19.7408
1978	159.936	283.726	131.564	28.3726
1979	241.184	415.290	199.655	41.5290
1980	363.705	614.945	302.211	61.4945
1981	548.468	917.155	456.752	91.7155
1982	827.089	1373.91	689.698	137.391

Table C-7

Projected Gross Investment (I3), Capital Stock (K3), Net Investment (NI3) and Replacement (REP3) of the Industry Sector (1973-82)
(Alternative II: Projection Under the Fifth Plan's Conceived Investment Growth Rates)

(Billion rials: at Constant Prices of 1960)

Years / Variables	I3	K3	NI3	REP3
1973	98.2395	548.184	70.8303	27.4092
1974	112.877	619.014	81.9265	30.9507
1975	129.696	700.941	94.6488	35.0470
1976	149.021	795.590	109.241	39.7795
1977	171.225	904.831	125.983	45.2415
1978	196.737	1030.81	145.196	51.5407
1979	226.051	1176.01	167.250	58.8005
1980	259.733	1343.26	192.569	67.1630
1981	298.433	1535.83	221.641	76.7915
1982	342.899	1757.47	255.026	87.8736

Table C-8

Projected Gross Investment (I4), Capital Stock (K4), Net Investment (NI4) and Replacement (REP4) of the Services Sector (1973-82)
(Alternative I: Projection Under the Fifth Plan's Conceived Investment Growth Rates)

(Billion rials: at Constant Prices of 1960)

Years	Variables I4	K4	NI4	REP4
1973	91.5278	392.468	71.9044	19.6234
1974	127.315	464.372	104.097	23.2186
1975	177.095	568.469	148.672	28.4234
1976	246.340	717.141	210.483	35.8570
1977	342.659	927.624	296.277	46.3812
1978	476.638	1223.90	415.443	61.1950
1979	663.003	1639.34	581.036	81.9672
1980	922.238	2220.38	811.219	111.019
1981	1282.83	3031.60	1131.25	151.580
1982	1784.42	4162.85	1576.28	208.143

Table C-9

Projected Gross Investment (I1), Capital Stock (K1), Net Investment (NI1) and Replacement (REP1) of the Agriculture Sector (1973-82)
(Alternative II: Projection Under the Observed Investment Growth Rates)

(Billion rials: at Constant Prices of 1960

Years	Variables I1	K1	NI1	REP1
1973	16.1280	66.6185	12.7971	3.33093
1974	18.0634	79.4156	14.0926	3.97078
1975	20.2310	93.5082	15.5556	4.67541
1976	22.6587	109.064	17.2055	5.45319
1977	25.3777	126.269	19.0643	6.31346
1978	28.4230	145.333	21.1564	7.26667
1979	31.8338	166.490	23.5093	8.32449
1980	35.6539	189.999	26.1539	9.49996
1981	39.9323	216.153	29.1247	10.8077
1982	44.7242	245.278	32.4603	12.2639

Table C-10

Projected Gross Investment (I2), Capital Stock (K2), Net Investment (NI2) and Replacement (REP2) of the Oil Sector (1973-82)

(Alternative II: Projection Under the Observed Investment Growth Rates)

(Billion rials: at Constant Prices of 1960)

Years / Variables	I2	K2	NI2	REP2
1973	14.8240	68.7415	7.94985	6.87415
1974	16.1582	76.6913	8.48903	7.66913
1975	17.6124	85.1803	9.09436	8.51803
1976	19.1975	94.2747	9.77004	9.42747
1977	20.9253	104.045	10.5208	10.4045
1978	22.8086	114.566	11.3520	11.4566
1979	24.8613	125.918	12.2696	12.5918
1980	27.0989	138.187	13.2801	13.8187
1981	29.5377	151.467	14.3910	15.1467
1982	32.1961	165.858	15.6103	16.5858

Table C-11

Projected Gross Investment (I3), Capital Stock (K3), Net Investment (NI3) and Replacement (REP3) of the Industry Sector (1973-82)
(Alternative II: Projection Under the Observed Investment Growth Rates)

(Billion rials: at Constant Prices of 1960)

Years / Variables	I3	K3	NI3	REP3
1973	94.0500	548.184	66.6408	27.4092
1974	103.455	614.825	72.7138	30.7412
1975	113.801	687.539	79.4236	34.3769
1976	125.181	766.962	86.8324	38.3481
1977	137.699	853.795	95.0089	42.6897
1978	151.468	948.803	104.028	47.4402
1979	166.615	1052.83	113.974	52.6416
1980	183.277	1166.81	124.937	58.3403
1981	201.605	1291.74	137.017	64.5871
1982	221.765	1428.76	150.327	71.4380

Table C-12

Projected Gross Investment (I4), Capital Stock (K4), Net Investment (N14) and Replacement (REP4) of the Services Sector (1973-82)

(Alternative II: Projection Under the Observed Investment Growth Rates)

(Billion rials: at Constant Prices 1960)

Years / Variables	I4	K4	NI4	REP4
1973	73.0380	392.468	53.4146	19.6234
1974	81.0722	445.883	58.7780	22.2941
1975	89.9901	504.661	64.7571	25.2330
1976	99.8890	569.418	71.4181	28.4709
1977	110.877	640.836	78.8350	32.0418
1978	123.073	719.671	87.0897	35.9835
1979	136.611	806.761	96.2733	40.3380
1980	151.639	903.034	106.487	45.1517
1981	168.319	1009.52	117.843	50.4760
1982	186.834	1127.36	130.466	56.3682

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