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The most generally accepted approaches of quantitatively forecasting manpower requirements by industries and occupations are described and evaluated. The operational steps of each forecasting technique are spelled out fully and illustrations of their use are made for (1) the econometric method, (2) the productivity method, (3) the trend projection method, (4) the employer's survey method, (5) the method of forecasting specialized manpower requirements, (6) the inter-area comparisons method, and (7) the elasticity of factor substitution method. An attempt has been made to comprehensively survey the literature concerning manpower forecasting, and a selected bibliography of 153 items is included. The bibliography is classified on the basis of the 7 methods of forecasting with short explanatory notes regarding some of the materials. A separate chapter is devoted to the data requirements in manpower forecasting in general, and to survey of the sources of data in Ontario. Another chapter, "Coordinating Educational Planning with Manpower Forecasting," discusses the problem of translating "crude" labor requirements, as derived through some appropriate forecasting technique, into qualified labor requirements, and then deriving the appropriate educational requirements. (ET)

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Methods of Forecasting Manpower Requirements

With Special Reference to the Province of Ontario

by

Ozay Mehmet

A Study prepared for the

ONTARIO DEPARTMENT OF LABOUR

and the

CENTRE FOR INDUSTRIAL RELATIONS
UNIVERSITY OF TORONTO

1965

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FOREWORD

THIS monograph is the first of a number of joint publications which the Centre for Industrial Relations at the University of Toronto and the Research Branch of the Ontario Department of Labour intend to sponsor from time to time on various research projects in which the two organizations share a mutual interest.

The object of this report is to describe the techniques available for estimating manpower requirements. The research was conducted by the author, Mr. Ozay Mehmet, during the summer of 1965.

The report has two special features. The first is a list of studies and statistics available for Canada and Ontario relating to different forecasting techniques. The second is an extensive bibliography which is indexed by forecasting method.

Copies of this monograph may be purchased for two dollars and fifty cents ($2.50) each from either the Centre for Industrial Relations at the University of Toronto or the Research Branch of the Ontario Department of Labour.

We wish to thank Mr. Mehmet for preparing this monograph and Professor Noah M. Meltz of the Department of Political Economy at the University of Toronto for supervising his work.

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Director,
Centre for Industrial Relations,
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June, 1966

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—O. M.

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chapter one

INTRODUCTION

THE purpose of this study is to describe and evaluate the various methods of forecasting manpower requirements by industries and occupations. Altogether seven such methods are studied:

(1) The econometric method,
(2) The productivity method,
(3) The trend projection method,
(4) The employers' survey method,
(5) The method of forecasting specialized manpower requirements,
(6) The inter-area comparisons method, and
(7) The elasticity of factor substitution method.

Since educational planning is an integral part of manpower planning, and as such essential to all methods of forecasting, the relationship of education and manpower forecasting is discussed in a separate chapter.

There is no universally accepted or settled methodology for manpower forecasting. For this reason the titles enumerated above are by no means established ones. However, an attempt has been made to present the most generally accepted approaches.

The general approach in this study is primarily descriptive. The operational steps of each forecasting technique are spelled out fully and clearly. References are frequently made to the actual experience of various manpower planning agencies in a number of countries in order to supplement theory with practice.

An attempt has been made to survey the literature on the subject of manpower forecasting as comprehensively as possible, and a fairly complete bibliography is attached. This bibliography is classified on the basis of the seven methods of forecasting studied in the text. There are also short explanatory notes regarding some of the material included in the bibliography.

A separate chapter is devoted to the data requirements in manpower forecasting in general, and to a survey of the sources of data in Ontario.

The study does not attempt to justify quantitative manpower forecasting (i.e., the calculation of manpower requirements). Instead, it is explicitly assumed that such work is both worthwhile and useful for enlightened policy-making.[1]

Manpower planning, just as other kinds of economic planning, inevitably entails welfare (i.e., normative) implications since it tends to alter, in some way, the future supply and demand conditions in the labour market, the relative prices of goods and services, and the distribution of national income. Analytically, it would be necessary for the manpower planner to study and attempt to justify the effects of manpower planning on the change in social real income during the forecast period. Such an attempt is outside the scope of the present study.

Other basic assumptions underlying the study are as follows: that the fundamental social and economic structure of the economy in the forecasting period will remain more or less the same as at the beginning of that period; that the maintenance of full employment will be a policy objective; and that war and similar calamities will not occur. Further assumptions pertaining to particular methods have been postulated in the appropriate places in the text.

[1]For such a justification, see Development of Manpower Forecasting Concepts and Procedures, a mimeographed paper prepared by the Ontario Department of Labour, Research Branch, June, 1965.

chapter two

THE ECONOMETRIC METHOD

THE econometric method of manpower forecasting is a technique for deriving occupational labour requirements from estimated levels of final demand for goods and services in the economy in some future year. The novelty of the method is its use of the conventional input-output analysis as an analytical tool for forecasting manpower requirements.

STEPS COMPRISING THE ECONOMETRIC METHOD[1]

Essentially, the steps comprising this method consist of:

(i) the construction of an input-output table showing the inter-industry flows and levels of final demand;

(ii) the recasting of the input-output table into a matrix showing the input ratios or coefficients characteristic of each sector;

(iii) the derivation of aggregate manpower requirements from production levels; and

(iv) the construction of a sector by occupation matrix showing the distribution of aggregate manpower requirements into specific occupations and occupational requirements.

The appendix at the end of this chapter presents a simplified description and illustration of these steps.

USE OF THE ECONOMETRIC METHOD IN OTHER COUNTRIES:

Although input-output tables have been published for some 40 countries since the pioneer studies of W. W. Leontieff some thirty years ago,[2] the number of countries which have used this technique as a tool of manpower forecasting is still very small. Only the United

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[1]The procedure suggested here is by no means a settled and accepted piece of theory, although it is very similar to the model currently being developed at the BLS under the Inter-Agency Growth Project. See: J. Alterman, "The Inter-Agency Growth Project," Long-Term Manpower Projections, ed. R. Gordon. (Proceedings of a conference conducted by the Research Program on Unemployment and the American Economy, University of California, Berkeley, June 25-26, 1964). Institute of Industrial Relations, Berkeley, University of California, 1965.

[2]"Quantitative Input and Output Relations in the Economic System of the United States," The Review of Economic Statistics, vol. XVIII, 1936, no. 3, pp. 105-25; and The Structure of American Economy, 1919-39, New York, Oxford University Press, 1951.

States,[3] the United Kingdom,[4] the Scandinavian countries, and a few others in Europe have undertaken serious work in this field. This, of course, is partly explained by the costliness and elaborateness of the technique itself and partly by the fact that manpower planning and forecasting is a relatively new area of economic policy.

In the United States there have been two major attempts at manpower forecasting using the econometric approach: the Bureau of Labor Statistics (BLS) study of 1955[5] and the model currently being developed at the BLS under the Inter-Agency Growth Project. The purpose of the 1955 study was to compute an occupational - industry matrix for the American economy and use it for forecasting the requirements of some 150 occupations arranged on the basis of nine major occupational categories (ranging from professional and technical workers to farm workers). The methodology employed was to construct, in the first place, a matrix for a base-year (i.e., the census year of 1950) on the basis of existing data, empirical studies, special sector analyses and other factors which threw light on the relative sizes of occupations used in the matrix. This matrix could then be adjusted for the specified target-year in view of expected changes in occupational compositions thereby obtaining magnitudes of occupational requirements. In some cases, it was observed that the direction of change in occupational compositions could be predicted from current knowledge of trends, prospects and conditions of the appropriate industry; in such cases, the information was utilized by making the necessary adjustments to the relative occupational weights in the matrix. In those cases where no predictions regarding changes in occupational compositions could be made, it was assumed that base-year weights would hold.

The Inter-Agency Project relies on the conventional input-output analysis. It starts by assuming alternative rates of growth in population, labour force, and labour productivity and obtaining alternative magnitudes of (projected) GNP. Then levels of final demand are projected and an input-output table consistent with both intermediate and final demands is constructed. Input coefficients underlying the table are actually projections of the base-year coefficients adjusted, where necessary, to take into account anticipated changes in coefficients during the forecast period. The aim is to derive manpower requirements for 1970. Finally, projections of industry outputs are translated

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[3]U.S. BLS, Division of Manpower and Employment Statistics, "An Occupational - Industry Matrix for the U.S." ed. R. Gordon, Long-Term Manpower Projections.

[4]Reports in the series entitled A Programme for Growth, Department of Applied Economics, Cambridge University.

[5]U.S. Dept. of Labor, BLS Division of Manpower and Employment Statistics. An Occupational - Industry Matrix for the U.S., 1955.

into occupational manpower requirements on the basis of expected changes in labour productivity and changes in capital requirements.[6]

The Cambridge model for the British economy was designed to obtain an employment matrix for 1970. The economy was divided into 31 sectors. The first task of the analysts was to estimate the potential labour force in 1970. Official projections of the labour force were used as the starting point. An allowance of 1.5% unemployment was made and also adjustments were made with respect to prices, wage-rates, and the rate of return on fixed assets.

The labour force was divided into three main occupational categories: managerial, clerical and technical, and the last of these was in turn subdivided into five categories: qualified manpower, technicians, craftsmen, operatives and unskilled. The census of 1951 was used as the source for estimating the number of workers engaged in each of these occupational categories for each of the 31 sectors and for government services. Then an attempt was made to study economic fluctuations, technological changes, and sociological pressures which tend to affect conditions in the labour market. In the light of these studies, weights were worked out and applied to the 1951 position to derive the distribution of labour force by skills and by sectors for 1970.[7]

In the Netherlands, econometric models are used mainly for short-term (i.e., annual) employment forecasts.[8] These forecasts are prepared separately for the private (including publicly owned enterprises) and public sectors. With regard to the latter, forecasts are made on the basis of four components: military forces, teaching staff, and others subdivided into central government and lower public authorities. It has been found that these categories usually change gradually and smoothly so that as a result simple linear trends can be fitted.

On the other hand, employment forecasts for the private sector are obtained from the econometric global short-term model used by the Central Planning Bureau for its annual forecasts. The model contains some 36 equations describing the most important structural relationships in the Netherland economy. The equation by which employment is determined contains a variable for total volume of sales exclusive of stock formation, one for the level of gross profits per unit of product, and another for the ratio of the import price level to the domestic price level.

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[6]For further details, see J. Alterman, op. cit. Also see, by the same author The Federal Government's Program for Economic Growth Studies, a paper given at the 7th Annual Forecasting Conference, American Statistical Society, New York, 23rd April, 1965 (mimeographed), where he gives detailed information regarding recent experiments of the Program.

[7]See R. Stone, "The Model in Its Environment, A Progress Report," July, 1964, No. 5 in the series entitled A Programme for Growth Series, Cambridge, England, Chapman & Hall, 1964, pp. 51-3.

[8]See article by P. de Wolff in Employment Forecasting, Paris, O.E.C.D., pp. 79-103, (final report).

Although the input-output technique has been used in Canada to measure inter-industry relationships,[9] it has not yet been used as a tool of manpower forecasting. However, the input-output table for 1961, which is currently being prepared by the Dominion Bureau of Statistics (DBS), is expected to provide an industry-occupation matrix. There are no econometric models of the Ontario economy, but the Provincial Department of Economics and Development is preparing an input-output table.

RESULTS OF THE APPLICATION OF THE ECONOMETRIC METHOD IN OTHER COUNTRIES:

The econometric method of manpower forecasting is in a developmental stage in each of the countries mentioned. In all cases a major obstacle is the insufficient amount of detailed data available regarding the structural relationships within the economy.

In terms of particular experiences the following findings and observations have been made:

An evaluation of the BLS (1955) matrix has shown the following areas of weakness:[10] (i) there was insufficient data available of the degree of refinement needed by the matrix; (ii) the static nature of occupational relationships adversely affected the usefulness of the matrix as a tool for forecasting occupational requirements. It was concluded that because there are continuing changes in the occupational patterns in all cases, the industry sectors in the matrix should be brought up to date from time to time by the introduction of new data to be obtained by means of empirical and special studies.

On the other hand, detailed information regarding requirements for some 150 important occupations and major occupational groups were obtained. The conclusion was that "the occupational matrix constitutes a flexible analytical tool, capable of being sharpened and adjusted as resources and time permit, and thus continually improved for a variety of uses."[11]

Regarding the British model, it was explicitly stated that it "is a very crude method of estimation, and we have only used it as a first device to feel our way into the subject."[12]

The Netherland model, which was started in 1961, is considered to be in its developmental stage. However, it was found that the correlation between actual and computed employment during the period for which the model was applied has been very satisfactory.[13]

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[9]See Canada. Dominion Bureau of Statistics. "The Inter-Industry Flow of Goods and Services," 1949, Ref. Paper No. 72, 1956.

[10]U.S. BLS Division of Manpower and Employment Statistics. An Occupational - Industry Matrix for the U.S. 1955, pp. 28-30.

[11]Ibid, p.30.

[12]R. Stone. The Model in its Evironment, A Progress Report, July, 1964, No. 5, p. 52.

[13]P. de Wolff, op. cit. p. 91.

GENERAL EVALUATION OF THE ECONOMETRIC METHOD:

(i) *Weaknesses:* The major weakness of the econometric approach to manpower planning and forecasting, as can be seen from the experience of the countries referred, is the inadequacy of factual information and data of the required detail and refinement. Other limitations of the method are that it is costly, time-taking, and that it requires a fair-sized team of experts and analysts. This is especially so when the number of sectors and occupations included in the occupational matrix is large. Finally, it should be realized that mathematical models should never be applied mechanically; there is need for human judgment to test the reasonableness of the results of such models.

(ii) *Advantages:* The econometric method is capable of yielding refined and useful forecasts of manpower requirements by specific occupations, and it does this within the framework of the structural relationships of the entire economy. This means that manpower forecasting and planning is made an integral part of a global economic development policy and a very high degree of internal balance in the 'master plan' is thus obtained. Also, the econometric method enables the derivation of very valuable information about the structure and working of the economy and such important factors as consumption, investment, prices, factor proportions, production levels and so on. The occupational - industry matrix can be kept up to date by periodic revisions after empirical studies; thus, it becomes a very useful and flexible tool of manpower policy as well as of general economic growth policy. Finally, it may be mentioned that it also affords an excellent opportunity to train staff in the use and application of modern econometric techniques to analyze economic problems.

ECONOMETRICS AS A TOOL OF EDUCATIONAL PLANNING:

Before ending this chapter, it would be interesting to refer to a relatively new but growing area of manpower planning, where the econometric technique is becoming increasingly useful and fruitful. This is the field where economists like Tinbergen, Bos and Correa[14] are the leading authorities. These economists are using the econometric techniques to co-ordinate educational and manpower forecasting, and to derive the optimal structure of the educational system which would allow the economy to grow at a prescribed rate of growth. The purpose of these models of optimum education system is to derive educational requirements from occupational and skill requirements. These models have been applied in Spain, Turkey and Greece under the O.E.C.D. Mediterranean Regional Project as discussed on p. 50 below.

[14]See, O.E.C.D., Education and Development, Technical Reports, Econometric Models of Education and Some Applications, Paris, 1965; H. Correa and J. Tinbergen: "Quantitative Adaptation of Education to Accelerated Growth," Kyklos, vol. 15, 1962, pp. 776-86.

APPENDIX TO CHAPTER TWO

THIS appendix is devoted to a description of a simplified econometric model for forecasting occupational manpower requirements. The presentation follows the procedure indicated at the start of the chapter.

(i) INPUT-OUTPUT TABLE:

Only the barest outlines of an input-output table are presented here.[1]

The justification for the inclusion of a description of the input-output analysis here is that it forms an integral part of the econometric method for manpower forecasting.

Consider a hypothetical simplified economy consisting only of two sectors: A and M, where the supply of labour is exogeneously determined, where each sector produces only its characteristic product and no other, and where labour is not a consumption good. We also assume that levels of final demand are specified from outside the model. These assumptions, which simplify away many practical and conceptual difficulties, are fundamental to any input-output table.

Table I is an input-output table for such an economy: it shows the inter-industry transactions and disposal of output by final use. The two productive sectors are each listed twice, once horizontally and once vertically, to indicate the fact that they are both sellers and buyers—selling output and buying input. This interdependence is the focus of the input-output system.

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[1]For further information regarding the theory and construction of input-output tables reference may be made to: (besides the standard works of Leontieff and others) Input-Output Analysis; An Appraisal: Studies in Income and Wealth. New York, Princeton University Press, 1955, vol. 18, part I, (particularly the papers by W. Leontieff, W. D. Evans and M. Hoffenberg, and C. F. Christ). Also, see vol. 18, part II of the same series; W. D. Evans and M. Hoffenberg: "The Inter-Industry Relations Study of 1947," The Review of Economics and Statistics, vol. 34 (May, 1952), pp. 97-142, contains a brief description of the conceptual and practical problems of the 1947 (U.S.A.) study, as well as useful comments on the history, theory, data requirements, and areas of use of input-output analysis. A somewhat more mathematical treatment of the subject is contained in R. Dorfman, P. A. Samuelson, and R. M. Solow; Linear Programming and Economic Analysis, the RAND Series, McGraw-Hill Book Co., 1958, chapters 9 and 10.

Regarding the Canadian economy, reference should be made to: Canada. Dominion Bureau of Statistics, The Inter-Industry Flow of Goods and Services, 1949, Ottawa, Queen's Printer, 1966 (Reference Paper No. 72); J. Sawyer; "The Measurement of Inter-Industry Relationships in Canada," Canadian Journal of Economics and Political Science, vol. 21 (November, 1955), pp. 480-97, gives considerable additional information about the 1949 study. Information regarding the construction of input-output tables for Canada for 1961, currently being prepared by the DBS and to be published in the near future, may be obtained from T. Gigantes and P. Pitts; "An Integrated Input-Output Framework and Some Related Analytical Models." This paper was read at the Canadian Political Science Association's Conference on Statistics at University of British Columbia, Vancouver, B.C., June 12-3, 1965 (mimeographed copies at DBS); Caves and Holton; The Canadian Economy: Prospect and Retrospect, Cambridge, Mass., Harvard University Press, 1959, chapter 14, is devoted to a discussion of an inter-industry table for Canada for 1970.

TABLE I

INPUT-OUTPUT TABLE ($ million)

	A-sector	M-sector	Final Demand	Total Output
A-sector	32	20	108	160
M-sector	40	60	100	200
Labour Services	60	30	0	90
Total Outlay	132	110	208	450

Read horizontally, the table displays the disposition of the total sectoral output (shown in the last column) amongst the productive sectors (collectively making up the so-called intermediary demand) and final demand. This last item represents consumption, investment, exports and change in stocks. In our simple economy, A-sector uses $32m worth of its total output itself, delivers $20m worth to the M-sector, and $108m worth to final demand.

The third row represents the primary factor, labour, the supply of which is assumed to be exogeneously determined. In Table I, 60 units of labour are allocated to the A-sector, and 30 units to the M-sector. 0 represents the fact that in our economy labour is used only as an input, not as a consumption good.

Read vertically, the table depicts the origin of inputs going into the production of the total output of each sector. In other words, the columns show the composition of total outlay of each sector corresponding to the specified levels of sectoral outputs in the final column. For example, in order to produce a bill of goods worth $160m, the A-sector uses $32m of its own output, $40m of the output of the M-sector, and $60m worth of labour.

(ii) THE DERIVATION OF FIXED TECHNICAL COEFFICIENTS:

For use as an analytical tool, it is necessary to recast the input-output table into a matrix showing the fixed technical coefficients of each sector. These coefficients represent the ratio between each input to a sector and the total output of that sector. Table II is constructed on the basis of Table I. Thus, for every $160m worth of its output, the A-sector requires $32m worth of its own product (representing intra-sectoral flows) giving a technical coefficient of 0.20, $40m worth of M-output (representing inter-industry flows between the M and A-sectors) giving a technical coefficient of 0.25, and $60m worth of labour giving a technical coefficient of 0.374. Other coefficients can be read off from Table II.

TABLE II. — FIXED TECHNICAL COEFFICIENTS

	A-sector	M-sector
A-sector	0.20	0.10
M-sector	0.25	0.30
Labour Services	0.374	0.15

Technical coefficients are used to set up and solve a system of simultaneous equations in order to derive the level and distribution of aggregate output from exogeneously specified levels of final demand for goods.

To illustrate this in our hypothetical economy, let us assume that the aggregate final demand is \$145m, of which \$80m is for M-goods and \$65m for A-goods.

Using the coefficients in Table II and the specified levels of final demand, we construct the following system of equations:

$$A = 65 + 0.20A + 0.10M$$
$$M = 80 + 0.25A + 0.30M$$

where A and M represent the aggregate outputs of the A and M sectors respectively.

Solving these equations, we obtain the results as tabulated in Table III.

TABLE III

LEVEL AND DISTRIBUTION OF TOTAL OUTPUT
(\$ million)

	A-sector	M-sector	Final Demand	Total Output
A-sector	20	15	65	100
M-sector	25	45	80	150
Labour Services	37.4	22.5	0	59.9
Total Outlay	82.4	82.5	145	30[illegible] 9

Since levels of final demand are exogeneously given, it follows that if we know these levels for some future target-year, we can calculate the projected or expected level and distribution of total output and thence derive labour requirements, as shown below.

ASSUMPTIONS UNDERLYING FIXED TECHNICAL COEFFICIENTS:

Before proceeding to the next step (i.e., the derivation of aggregate manpower requirements from production levels) a few remarks regarding the assumptions behind fixed technical coefficients may be in order.

The fundamental assumption underlying the input-output matrix is that each input into a sector is proportional to the total output of that sector, and it is assumed that this proportion is constant; hence the label 'Fixed Technical Coefficients'. It is important to note that 'fixed technical coefficients' are 'fixed' in relation to the scale of output, not fixed through time: In our hypothetical illustration, the coefficients of the A-sector, for example, are assumed to stay the same whatever the volume of A-output at the base time-period, but they need not stay the same between two particular time-periods. Nonetheless, effective use of input-output analysis presumes that technical coefficients are fairly stable over time. Fortunately, there is evidence to doubt whether they often change to any great extent within relatively short periods of time.[2]

Yet, the assumption of fixed technical coefficients does represent a major limitation of the input-output analysis. This is partly due to the asymmetric nature of technical change which will disturb the technical conditions of production as shown by the initial technical coefficients. The assumption of fixed technical coefficients implies that technical change leaves factor proportions unaltered. In reality, however, technical change is seldom symmetric, and asymmetric technical change is likely to cause alterations in factor proportions through induced factor substitution. Moreover, factor proportions may also be altered in response to changes in relative factor prices resulting from cyclical or seasonal supply changes. Thus, the use of fixed technical coefficients is liable to involve unrealistic assumptions regarding the technical conditions of production.

It must be remembered that the use of fixed technical coefficients is due to practical, not theoretical, necessity. For while it is theoretically possible to integrate variable coefficients in an input-output model,[3] there are usually not enough detailed facts about the structural relationships in an economy to enable the practical use of variable coefficients. Of course, if non-linear equations are introduced into the model, the input-output system will become more complex and the difficulties of computing and solving the simultaneous equations will increase.

(iii) THE DERIVATION OF AGGREGATE MANPOWER REQUIREMENTS FROM PRODUCTION LEVELS:

The next step involves the derivation from (projected) future production levels, of the aggregate manpower requirements of each sector necessary to achieve those production levels. We can illustrate this operation by going back to our simplified hypothetical model.

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[2]See R. Stone and G. Croft-Murray; Social Accounting and Economic Models, London, Bowes and Bowes, 1959, p. 48; and J. Hurtle; "Input-Output Analysis as an Aid to Manpower Policy," International Labour Review, vol. 65, 1952, pp. 623-4.

[3]Regarding studies on variable coefficients, see Cambridge University, Department of Applied Economics; Input-Output Relationships, 1954-66, A Programme for Growth, no. 3, chapter 3.

Labour input coefficients in our hypothetical economy are shown in the third row of Table II. These labour input coefficients have exactly the same characteristics as the other technical coefficients discussed above.[4] They represent the ratio of labour input to the total output of a particular sector.

In the arithmetic example given above, to find aggregate sectoral labour requirements, we assume that labour input coefficients of Table II remain unchanged. By applying these coefficients to the new levels of output of Table III, we derive aggregate labour requirements corresponding to these output levels. These labour requirements are shown in the third row in Table III.

Since the labour requirements in Table III are in dollar values, we need to know output per man-year (in dollar terms) in order to obtain manpower requirements in terms of workers or man-years. This entails study of empirical trends in output per man-hour and hours worked per man-year. On the basis of these studies we can derive the value of output per man-year. By dividing the dollar value of labour requirements by the value of output per man-year, we obtain labour requirements in terms of man-years. This will give us aggregate sectoral labour requirements implied by the target-year output levels. In our hypothetical model, if we assume that output per man-year in A-sector is $4000 and in M-sector it is $5000, then labour requirements implied in Table III are 9,350 man-years for the A-sector, and 4,500 man-years for the M-sector.

(iv) DISTRIBUTION OF AGGREGATE LABOUR REQUIREMENTS INTO OCCUPATIONAL REQUIREMENTS:

From the point of view of manpower forecasting, this step is the least definitive because factors affecting inter-occupational relationships are complex and difficult to quantify in a unique manner.

Our aim is to construct a sector by occupation matrix, and allocate aggregate sectoral manpower requirements amongst specified occupational categories. Let us assume that in our hypothetical economy there are three occupations X, Y and Z. We have already derived aggregate sectoral labour requirements for the A and M sectors. We can therefore set up the following sector by occupation matrix on the basis of the following occupational employment ratios: $X_A = 20\%$, $Y_A = 30\%$, $Z_A = 50\%$ and $X_M = 25\%$, $Y_M = 45\%$, $Z_M = 30\%$.

[4]Recent attempts have been made to use variable labour input coefficients, but so far no major breakthrough has been achieved. See, J. Alterman; "The Federal Government's Program for Economic Growth Studies," a paper given at the 7th Annual Forecasting Conference, American Statistical Society, New York, April 23, 1965 (mimeographed).

TABLE IV

A HYPOTHETICAL SECTOR BY OCCUPATION MATRIX

	X	Y	Z	Total
A-sector	1,870	2,805	4,675	9,350
M-sector	1,125	2,025	1,350	4,500
Total	2,995	4,830	6,025	13,850

Table IV shows sectoral labour requirements (last column), aggregate occupational requirements (bottom row), and the allocation of occupational requirements between the sectors. Such a table is very informative for the manpower policy-maker and is an essential guidestick for shaping future educational and training programmes.

chapter three

THE PRODUCTIVITY METHOD

THIS method, which is the main method used in the OECD Mediterranean Regional Project,[1] tries to determine the level of target-year employment, by sector and occupation, on the basis of two hypotheses: one regarding change in labour productivity,[2] the other regarding the growth of output.

The productivity method is by no means the only one using the productivity concept; indeed, all other methods discussed in this study explicitly or implicitly make use of productivity. The novelty of the productivity method is that manpower requirements are directly derived from the hypotheses regarding labour productivity and output growth during the forecast year.

STEPS COMPRISING THE PRODUCTIVITY METHOD:

The method described here consists of the following analytical steps:

(i) determination of output in the target-year for the whole economy and for each principal sector;

(ii) derivation of total employment in the target year and the estimation of sectoral manpower requirements on the basis of estimates of productivity in each principal sector;

(iii) derivation of occupational requirements from sectoral totals;

(iv) conversion of 'crude' labour requirements into trained manpower and the derivation of educational requirements;

(v) comparing requirements with supply; and

(vi) re-assessment of the preceding steps in the light of anticipated labour market imbalances.[3]

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[1] See the various OECD publications included in the Bibliography.

[2] Defined as output per man-hour expressed in terms of constant dollars.

[3] The scheme outlined here is very similar to the OECD one. See: OECD Critical Evaluation of the First Stage of the MRP, Paris, 1965, chapter 3.

(i) DETERMINATION OF OUTPUT:

Output in the target year may either be obtained from an agency directly responsible for such forecasts, or, when that is not possible, estimated by the manpower forecasting agency itself.[4]

There are a number of ways of forecasting output. One comprehensive method is to use the input-output analysis as a forecasting tool. From a careful study of inter-industry transactions and anticipated changes in the levels of the components of final demand (i.e., consumption, investment, exports) it is possible to project the level of aggregate final demand in the target year, and then to calculate the sectoral output levels which would be needed to sustain the projected level of final demand.[5] Or one can make an informed estimate regarding output growth during the forecast period on the basis of any available relevant indicators (e.g., changes in per man or man-hour productivity, capital/labour ratio, or supply conditions). This appears to have been used by B. J. Drabble in his estimate of the potential Canadian output through to 1970.[6] An interesting approach, used by R. E. Caves and R. H. Holton[7] in forecasting the Canadian Gross National Product in 1970, is to assume a number of alternative growth rates and consequently obtain maximum and minimum levels; then a 'best guess' about the target-year output can be made by calculating the mean of the maximum and the minimum levels.

(ii) DERIVATION OF TARGET-YEAR MANPOWER REQUIREMENTS:

Once the target-year output is known, the task of the manpower forecaster is more than halved. The next problem is the quantification of the expected change in labour productivity during the forecasting period. This is done by means of empirical and special studies regarding (a) output per man-hour, and (b) hours worked per man-year. It is the former which is the troublesome variable because output per man-hour is mainly governed by technical conditions of production, which are very difficult to predict. Under the circumstances, one may examine probable changes in such variables as the capital/labour ratio, relative input prices, rate of return to fixed assets and so on. A mechanical approach would be to examine sectoral trends in output per man-hour, and man-hours worked.[8]

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[4]In either case, it is important to make sure that the target-year output is not derived on the basis of growth of total labour force deduced from population projections by means of participation rates. This is circular reasoning in that something is being derived which has already been included in the equation. See the article by G. Bombach in OECD Study Group in the Economics of Education; Economic Aspects of Higher Education, Paris, 1964, pp. 205-6.

[5]For a simple, non-mathematical description of input-output analysis see J. Burtle; "Input-Output Analysis as an Aid to Manpower Policy," International Labour Review, vol. 65, 1952, pp. 600-25, and references in the Bibliography.

[6]Economic Council of Canada, Potential Output, 1946-70, 1965. Staff Study, No. 2.

[7]The Canadian Economy: Prospect and Retrospect, Harvard University Press, 1959, table 39, p. 302.

[8]Drabble, B. J. Op. cit.

Having obtained target-year output, and quantified change in labour productivity, the level of actual employment in the target year can then be computed. Thus, let E_t = target-year employment which we want to find, Y_t = target-year output, P_t = target-year productivity, then we have:

$$E_t = \frac{Y_t}{P_t} = \frac{Y_t}{B_t C_t}$$

where B = output per man-hour, and C = hours of work per man-year in the target year.

More comprehensively we have:

$$E_t = \frac{(1 + a)\, Y_o}{(1 + b)\,(1 + c)\, P_o}$$

where a = percentage change in the value of output during the forecast period; b = percentage change of output per man-hour; c = percentage change in hours of work per man-year; Y_o = base-year value of output, P_o = base-year value of output per man-year.[9]

By repeating this process for each major sector and then summing up the sectoral totals, we can estimate total employment, by sectors, in the target year.

(iii) DERIVATION OF OCCUPATIONAL REQUIREMENTS:

The method of deriving occupational requirements is to set up a matrix for sector by occupations.[10]

The calculation of the actual contents of the industry-occupation matrix (i.e., the relative sizes of occupational categories) is more or less a process of trial and error. There is no unique way to distribute aggregate labour requirements into occupational categories. A considerable degree of judgment is essential.

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[9]To give an example, suppose we are given the following data concerning the base-year: Value of total output: $4 million; average employment during the year: 1,000 man-years; weeks worked per year: 50; average hours per week per worker: 40; output per man-hour (= value of total output divided by total man-hours per year): $2. Furthermore, suppose that we are given the following information regarding the target-year: Value of output will be 20% higher relative to base-year; output per man-hour will be 10% higher; hours worked per man-year will be 10% less. Then, using the above (comprehensive) formula, we can calculate that E_t = 1,212 man-years approximately. Subtracting the base-year employment from that of the target-year, we find the net growth of the labour force of the sector during the forecast period.

Incidentally, this example also indicates the kind of data required for the purposes of the productivity method for manpower forecasting.

[10]For examples of sector by occupation matrices see N. M. Meltz, Changes in the Occupational Composition of the Canadian Labour Force, 1931-61, Ottawa, Department of Labour, Economics and Research Branch, 1965, Occasional Paper No. 2, Tables A1-A4, pp. 116-119.

As a first approximation, it may be useful to extrapolate past occupational trends within industries. The size of each occupational category in the target-year may then be read off from the graph. The implication of this mechanical operation is that the same shifts in relative occupational sizes will take place in future as have occurred in the past.[11] This assumption is undoubtedly highly questionable, but as a first approximation it may be tolerated and used as a basis for further refinement.

Next, the estimates obtained by means of the above procedure may be refined by taking into account the effect of different factors influencing relative occupational compositions over time. N. M. Meltz, in his study of the changes and trends in the occupational composition of the Canadian labour force since 1931[12], has distinguished three major determinants of occupational trends: industrial output changes, industrial productivity changes, and occupational composition changes. It was found that industrial output changes and productivity changes tended to decrease the number of persons in agricultural occupations, and to increase the numbers in non-agricultural occupations, whilst occupational composition changes had a very important impact on service occupations.

Additionally, any useful and relevant information readily obtainable might be utilized appropriately in the matrix. For instance, special adjustments might be made in the case of those industries and/or occupations which are known to expand or contract during the forecast period.

It is important to note that, even after all these qualifications, the resulting matrix cannot be considered "unique", (i.e., the only feasible one) because by varying our assumptions regarding capital/labour ratios, the ratio of wage-rates to prices of fixed assets, we can get different solutions.

Thus, it can be observed that the derivation of specific occupational requirements is a somewhat inconclusive operation, and to this extent, disheartening from the point of view of the manpower forecaster. This is due to the difficulties inherent in forecasts of technical change and economic activity.

(iv) DERIVATION OF EDUCATIONAL REQUIREMENTS:

The problem of deriving educational requirements from 'crude' manpower requirements is a large and complicated issue. It is also an

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[11]See S. Olof-Doos, in Planning Educational Needs for Economic and Social Development, H. S. Parnes, (ed.), OECD, Paris, pp. 127-37.

[12]Changes in the Occupational Composition of the Canadian Labour Force, 1931-61, op. cit.

essential part of any method of manpower forecasting. For these reasons, the topic is discussed in a separate chapter, where a number of alternative approaches to the problem are reviewed.[13]

(v) BALANCING REQUIREMENTS WITH SUPPLY:

The balancing of occupational requirements with the normal flow of supply of occupational manpower (which, incidentally, can be quantified only in the case of those occupations which have a reasonably specific and identifiable educational background), is important from the point of view of labour market equilibrium in the target year. Where it is practicable, the analysis enables the forecaster to bring to light any probable structural imbalances in the educational and vocational training programmes.

The analysis can be illustrated in terms of symbols as follows: Let N be the net increase in the employment of persons engaged in a particular occupation during the forecast period, E the expected entrants into the occupation, and W total withdrawals therefrom. Therefore:

$$N = E - W \qquad (I)$$

In turn,

$$E = G - L \qquad (II)$$

where G represents the gross outflow of graduates from the appropriate educational institutions during the forecast period, and L stands for that portion of G which is expected not to enter the occupation or the labour force.

And,

$$W = D + R \pm I \pm M \qquad (III)$$

where D represents deaths, R retirements, I net inter-occupational transfers, and M net regional and/or international migration of the appropriate professionals.

Actual employment in the particular occupation in the target-year (T) is given by:

$$T = S + (G - L) - (D + R) \pm I \pm M = S + N \qquad (IV)$$

where S stands for employment in the base year.

Whether the labour market will manifest equilibrium in the target-year or not depends upon the relationship between net entry to the occupation during the forecast year and requirements. Thus, if equation (IV) holds, then the supply of and demand for the manpower under consideration will be balanced. If the left-hand side exceeds the right-hand side, there will be shortage which is likely to influence relative wages. In the reverse case there will be excess supply. In

[13]See Chapter IX below.

these latter two cases, the educational and training programmes are expected to reveal structural imbalances during the forecast period; the necessary policy measures should be self-evident.

(vi) A GENERAL RE-ASSESSMENT:

If and when there are special reasons (e.g., heavy unemployment or underemployment in the base-year) whereby the attainment of full-employment in future labour markets is made a deliberate policy-objective, then the requirements obtained by means of the steps outlined above should be compared with the projected total (potential) labour force. Dynamic equilibrium in the labour market requires that total (potential) labour force must be equal to the aggregate manpower requirements (allowances being made for frictional unemployment). Any imbalances will be reflected in wage-rates, or level of total output, or substitution between occupations, or any combination of these factors.

EMPIRICAL APPLICATION OF THE PRODUCTIVITY METHOD:

As was mentioned at the beginning of this chapter, this is the main method used in the Mediterranean Regional Project (MRP) in which six countries are participating: Greece, Italy, Portugal, Spain, Turkey and Yugoslavia.[14] In all cases, manpower forecasting is co-ordinated with, and integrated into the overall economic development plan, often called "a Long-term Perspective Plan". Manpower requirements, by sectors and occupations, are worked out on the basis of prescribed rates of economic growth. Consequently, 'requirements' are, in effect, indications of the types and magnitudes of manpower essential to meet the growth targets postulated in the first place. This kind of manpower forecasting is highly prescriptive, and if industry and other sectors fail to achieve the set growth targets, then imbalances in the labour markets are inescapable.

Central themes of the MRP country reports are the realization that "education is a primary instrument for economic and social development",[15] and that "there should be a rigorous re-assessment of the quantitative objectives of education"[16] in the light of the needs of the economy for qualified personnel. In the Greek Report it is stated that "if the educational system fails to produce the qualified personnel needed in each branch of economic activity, the manpower bottlenecks thus created will prevent, or at least impede the attainment of the targets set by the (economic) plans".[17] It is understandable, therefore, that the fundamental purpose of MRP studies is to attempt to promote a dynamic balance between the education system of the country in question and its qualified manpower needs.

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[14]See the individual country reports (mimeographed), Paris, OECD, 1964.
[15]Turkish Report, p. 1.
[16]Yugoslavian Report, p. 1.
[17]Greek Report, p. 2.

All six MRP countries have permanent manpower forecasting and planning agencies which are an integral part of the national machinery for economic planning and which maintain close and regular contacts with the OECD. Thus, manpower planning is carried on a systematic and established basis.

In all of the six MRP countries, studies undertaken constitute pioneering work. Consequently, results are rather tentative. However, in each case, valuable information and extensive data have been collected concerning the educational system and the various economic sectors of the economy. The fact that manpower planning is done on a permanent basis means that lessons of the past can help refine and develop future work.

CRITICAL EVALUATION OF THE PRODUCTIVITY METHOD:

Chapter 3 of the OECD publication "Technical Evaluation of the Mediterranean Regional Project"[18] gives a series of conceptual and practical difficulties and problems encountered in the six countries which participated in the project. The three main difficulties faced were: (i) the determination of the target-year output; (ii) the derivation of occupational requirements from aggregate sectoral requirements; and (iii) the formulation of a stable relationship between a specific education or training programme and a specific occupation.

First, insofar as the determination of target-year output was concerned, in all countries a desirable rate of growth was postulated (or more correctly, borrowed from the Development Plan). In Spain, 6% annual growth of GDP for the period 1961-75 was assumed.[19] In Turkey, the figure assumed was 7% for the period 1963-67.[20] In Greece, 7% was assumed for the period 1965-69.[21]

Sectoral productivity trends were projected partly on the basis of an overall impressionistic view of the home economy and partly by means of comparisons with other comparable countries.

As was pointed out above,[22] this approach is open to criticism on the ground that if output does not grow at the expected rate, then manpower forecasts should be revised. Since the probability of achieving the prescribed rate of output growth is not very high in any country at any given period of time due to the unforeseeable nature of the future course of economic activity, it follows therefore that such manpower forecasts cannot effectively serve as guides for educational planning. The need is therefore quite obvious: to develop a satisfactory method for projecting target-year output. The MRP studies have not, as yet, solved this problem.

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[18]Mediterranean Regional Project, "Technical Evaluation of the First Stage of the Mediterranean Regional Project," Paris, 1965 (mimeographed).
[19]Spanish report, p. 89.
[20]Turkish report, p. 30.
[21]Greek report, p. 28.
[22]p. 19.

With regard to the second problem, the derivation of occupational requirements from aggregate labour requirements was done mainly on the basis of special sectoral studies.[23] In these studies, past occupational trends, probable future prospects, experiences of other countries, and general knowledge of the economy were utilized. The basis of occupational groupings in all countries was the MRP classification.[24]

No generalized methodology for deriving occupational requirements could be developed in the MRP countries. The projects were exploratory and tentative. In the special sector studies undertaken, a considerable degree of necessarily subjective judgment was used.

The third problem pertains to the relationship between education and occupations. The MRP occupational groupings were developed on the basis of the principle that they should, as far as possible, be convertible into corresponding categories of educational qualification thereby facilitating educational planning. With this objective in mind, occupations listed in the International Standard Classification of Occupations[25] were fitted into four broad occupational classes according to the level of educational qualifications required for each occupation. The process of converting occupational forecasts into educational requirements was not a purely mechanical exercise; special assumptions were made for each country recognizing the unique characteristics and conditions in each case.

The MRP method has been criticized on the ground that it tends to neglect the effect of supply changes in future labour markets, and ignores the influence of inter-occupational mobility of labour on future levels of occupational requirements.[26]

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[23]See N. Erder's article in Planning Education for Economic and Social Development (ed.) H. S. Parnes, OECD, Paris.

[24]H. S. Parnes, Forecasting Education Needs for Economic and Social Development, Paris, 1962, Appendix B, pp. 77-88. In this classification, occupations are classified into 4 classes ranging from Class A (scientific and technical occupations) to Class D (farmers and unskilled occupations).

[25]International Labour Office, Geneva, 1958.

[26]OECD; Critical Assessment of the First Stage of the MRP, op. cit, p. 35.

chapter four

THE TREND PROJECTION METHOD

AN important and frequently used method for forecasting manpower requirements is to project past trends of aggregate and occupational labour forces through to the target-year and read off the requirements from the graph.

This method, which has a number of variations, requires the availability of time-series of the total labour force, by sectors and occupations, for a reasonable number of years (normally, at least ten), otherwise its use may become highly questionable. In each instance of application, it is up to the forecaster to decide how far back his time-series should go in order to yield a reliable trend. In this connection, a factor seriously to be taken into account, is the degree of the stability of the trend line: the less stable the trend line, the longer must be the time period.

THE FREEHAND EXTRAPOLATION METHOD:

Of the different variations of the trend projection method, the freehand extrapolation method is the simplest one. It consists of plotting the graph of the labour force series on a graph-paper and fitting a trend through it by means of a freehand extension of the graph, such that the trend appears to the eye to describe the long-term growth of the labour force. The weakness of this method is that it requires a high degree of subjective judgment since the forecaster is obliged to guess the magnitude and character of the future course of economic events.

THE SEMI-AVERAGE METHOD:

There is a relatively simple statistical technique for computing trend lines. The data are split into two equal groups and the figures in each half are then averaged. The averages thus obtained are in turn plotted against the centre year of the respective group, and a straight line is drawn through the two points. Extending this line to

the target-year, estimates of the labour force in that year may be derived. This, as can be observed, is but a mechanical operation and therefore should be handled with caution.

THE REGRESSION ANALYSIS METHOD:

This method is designed to be used in distributing the aggregate target-year labour force into sectoral and occupational categories. That is to say, its use presupposes the knowledge of total labour force in the target-year. Ususally, this initial operation is executed by applying participation rates to projected population figures.[1]

The method is usable only if there is a high degree of linear correlation between the aggregate labour force and the specific sectoral or occupational subdivision. This may be observed in a scatter diagram. (See Chart I on next page.) If the correlation is high, the dots will lie more or less along a straight line; if they scatter widely the correlation is low, and this method is not appropriate.

The method involves the use of the equation of the straight line: $Y=a+bX$. Aggregate labour force is denoted by X, and that of a specific subdivision by Y. The problem is to find Y, X already being known. This is done by finding the values of a and b, which are obtained from the following 'normal' equations:

$$\text{I.} \quad \sum(Y)=Na+b\sum(X)$$

$$\text{II.} \quad \sum(XY=a\sum(X)+b\sum(X^2)$$

where N is the number of years in the series.[2]

PRACTICAL APPLICATION OF TREND PROJECTION METHODS IN VARIOUS COUNTRIES:

A large number of countries use one or another variation of the trend projection method in order to obtain the sectoral and occupational breakdown of the projected total labour force. A widely used technique is to correlate the number of persons employed in a particular occupation with some reasonable indicator such as the total employed labour force, production, population and so on.

In Sweden, for instance, forecasts of the requirements for engineers are often made on the basis of an observed linear relationship between the density of engineers (i.e., percentage of engineers among the total number of persons employed) and productivity in each sector.[3]

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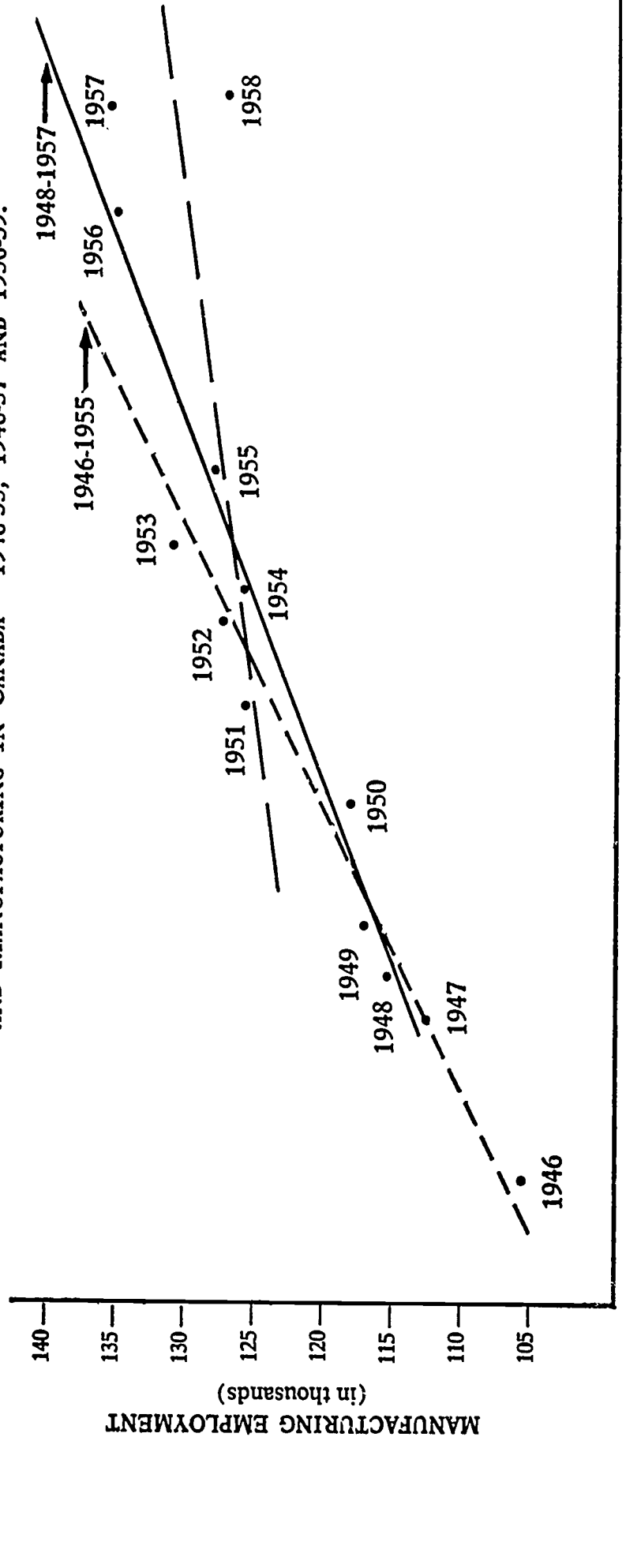
[1]For a useful, hypothetical illustration of this operation see U.S. Dept. of Labor, BLS; The Forecasting of Manpower Requirements, BLS Report No. 248, April, 1963, pp. 13-18.

[2]See Appendix at the end of this chapter for an illustration of this technique.

[3]OECD; Policies for Science and Education: Country Reviews: Sweden, October, 1962, pp. 22-24.

CHART I

SCATTER DIAGRAM OF TOTAL NON-AGRICULTURAL EMPLOYMENT AND MANUFACTURING IN CANADA — 1946-55, 1948-57 AND 1950-59.



In the Netherlands, forecasts of engineers have been made on the basis of a relation between the number of engineers and national income.[4]

In the U.S.A. the method which the BLS used to project the long-term demand for scientific and technical personnel was to obtain trends showing the density of scientists and engineers in each sector in relation to the total employment and economic activity in that sector, and then extrapolate these trends to the target-year, making allowances for expected changes in general economic activity and employment.[5]

In France, trend projection is employed for general long-term and medium-term forecasts. Experiences and trends in the proportion of active population employed in each sector of the economic activity of some ten other countries over the last 50 years, are examined. In the light of these studies, so-called 'standard curves' depicting the trend of employment in each branch of activity against total employment are plotted. These 'standard curves' are used as a basis for general reference in projecting past trends into the future.[6]

EVALUATION OF THE TREND PROJECTION METHOD:

No country using this method places complete reliance on it: in all cases it is supplemented by deliberate reorientation of the economy. Moreover, because of its questionable reliability, it is often used only for purposes of deriving fairly general or tentative forecasts.[7] To obtain finer and more precise forecasts other techniques are usually utilized.

A weakness of this method is that it requires a considerable amount of statistical data in the form of time-series going back a fair number of years. In the U.S. Department of Labor, BLS, this method is used only when data for 10 or more years are available.[8]

But the major weakness of the trend projection method is that the results are biased in favour of the shape of past trends. This can be illustrated by means of the example from the Hood and Scott Report cited in the Appendix to this chapter. Thus, if, instead of using 1946-55, which were generally speaking, years of steadily rising employment, we use 1950-59, in which case the recession years of 1958-59 replace the good, immediate, post-war years, we can observe that, though still using the assumption that total non-agricultural employment in the

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[4]Article by P. Wolff in Employment Forecasting: Final Report, OECD, March, 1963, and graphs 4 and 5 on p. 103.

[5]See National Science Foundation; Scientists, Engineers and Technicians in the 1960's: Requirements and Supply, NSF 63-34, U.S. Dept. of Labor, BLS; 1964. For a critical assessment of the American experience see Blank and Stigler: The Demand and Supply of Scientific Personnel, National Bureau of Economic Research, 1957, pp. 34-6.

[6]J. Fourastie in OECD: Employment Forecasting, Paris, 1963, pp. 63-4.

[7]Ibid., p. 64. Also The Forecasting of Manpower Requirements, BLS Report No. 248, April, 1963.

[8]BLS Report No. 248, op. cit. p. 26, footnote 22.

period 1979-81 equals 8.9 million, now manufacturing employment in the same period is 1.68 million, which is only about 69% of the previous forecast (i.e., 2.43 million). Again, if the period we used were 1948-57, then manufacturing employment would become 2.09 million.

These wide fluctuations in results obtained by the regression method illustrate the effect of the trend of the specific period used as the base of our projection on the results obtained from such projections. These fluctuations are fundamental to the regression method of forecasting. Such an inherent defect is particularly decisive when the series used is marked by business cycles or ups and downs. The implied moral is that this method must be used only within the framework of a fairly large number of years, and, moreover, since the method is purely mechanical, the result must be checked against rational judgment of future prospects.

Appendix to Chapter Four

To illustrate the application of the regression analysis method we shall compute a line of regression of manufacturing employment (denoted by Y) on total non-agricultural employment (denoted by X) in Canada during the post-war years. We shall use the projections of the Hood and Scott report[1] in order to obtain a value of X in some future year (in this instance 1979-81).

Table I shows the values of X and Y for the period 1946-55. Sources of data are shown at the bottom of the table.

Values of the variables of the 'normal' equations are readily obtained from the bottom row of Table I. Substituting we have:

$$1{,}215 = 10a + 4{,}050b \qquad (I)$$

$$494{,}719 = 4{,}050a + 1{,}651{,}106b \qquad (II)$$

Multiplying equation (I) through by 405, and then subtracting it from (II), we get: $b = 0.25$. Substituting this in (I), we derive the value of $a = 20.3$.

With the values of the two constants thus determined, the equation of the line $Y = a + bX$ can now be solved, which can then be fitted to the scatter diagram.

To obtain the value of Y in some future date, we must know the corresponding value of X. According to Hood and Scott, total non-agricultural employed labour force in 1979-81 will be 890 (in 10,000s). This gives us the value of X in 1979-81. Substituting the values of the two constants and X in the equation of the line, we can find Y in 1979-81. It is thus found that the manufacturing labour force in 1979-81 in Canada will be 242.8 (in 10,000s). Hood and Scott's estimate is 239.3 (in 10,000s) which, it will be observed, is comparable with our result.

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[1]Royal Commission on Canada's Economic Prospects, Output, Labour and Capital in the Canadian Economy, February, 1957, table 7.1, p. 311. The method Hood and Scott used was to project population to 1980 and derive total labour force by means of projected participation rates and an assumption that net immigration will amount to 75,000 per annum. Total labour force was allocated amongst industries on the basis of expected variations in labour productivity in various industries. These expectations were formulated through studies "devoted to the prospects for the resource industries, primary manufacturing and secondary manufacturing" (p. 309).

TABLE I

COMPUTATION OF A LINE OF REGRESSION OF MANUFACTURING EMPLOYMENT ON TOTAL NON-AGRICULTURAL EMPLOYMENT IN CANADA — 1946-55.

Year	Total Non-agricultural employment* (in thousands) X	Manufacturing employment** (in thousands) Y	X^2	XY
1946	348	106	121,104	36,888
1947	371	113	137,641	41,923
1948	378	116	142,884	43,848
1949	384	117	147,456	44,928
1950	396	118	156,816	46,728
1951	416	126	173,056	52,416
1952	428	129	183,184	55,212
1953	438	133	191,844	58,254
1954	436	127	190,096	55,372
1955	455	130	207,025	59,150
Total	$\sum X = 4,050$	$\sum Y = 1,215$	$\sum X^2 = 1,651,106$	$\sum XY = 494,719$

*Source: The Labour Force, Table 2; DBS, Cat. No. 71-001 (monthly).

**Source: The Manufacturing Industries of Canada, 1960, Section A, Summary for Canada, DBS, Cat. No. 31-203 (Annual) Table I.

chapter five

THE SURVEY METHOD

THE purpose of this method is to utilize the manpower requirements of employers for forecasting aggregate effective demand for manpower (and sometimes for employment in some selected occupations) at a target year. For these purposes, questionnaires and interviews may be organized among a sample of establishments in order to ascertain the employers' future manpower needs; the information thus obtained is then used as the basis for predicting target-year manpower requirements.

SELECTION OF THE SAMPLE:

The first step in the survey approach is to define explicitly the technique to be used in the selection of the sample of firms. Two of the most popular criteria for this purpose are the "size" and "leader" concepts: in the former instance, an attempt is made to include all establishments in the selected sector employing over a certain number of workers; in the latter case, those firms are included which are presumed to influence the policies of other firms in the sector. In practice, however, the difference between these two criteria may not be very significant. In all cases, a critical factor to be borne in mind is the ability of the selected firms to predict their future employment levels.

DEFINITION OF 'INDUSTRY':

Next it is necessary to formulate both an analytically sound and operationally feasible definition of 'industry'. Such a definition is suggested in *The Inter-Industry Flow of Goods and Services, Canada, 1949*,[1] in the following terms: "An industry is a group of establishments which have sufficient common characteristics that they may be grouped together for analytical purposes. They may, for example,

[1]Canada, DBS; Ref. No. 72, Ottawa, 1956, pp. 7-8.

manufacture similar end-products (the furniture industry) or they may all use the same component material (the iron and steel industry)".

COVERAGE OF THE SAMPLE:

It is also desirable that the proportion of total employment of the sample establishments to total employment in the industry should be fairly high. Ideally, the greater the degree of coverage the greater will then be the reliability of the sampling. In the Canadian Employment Forecasting Survey[2] (EFS), the actual employment of the respondent establishments in the manufacturing industry represented between 36% and 45% of the total manufacturing employment, whilst in the case of the non-manufacturing industries the degree of coverage ranged between 60% and 80%.[3] In the case of the U.S. Engineers' Joint Council Survey,[4] the coverage was about 20%.[5]

DERIVATION OF REQUIREMENTS:

Predictions about future manpower requirements may be derived from the survey results by means of an appropriate statistical technique. The one employed in the EFS case is to use the employment indexes published in the *Monthly DBS Employment and Payrolls Bulletin* as the base-period stock, and apply to it the ratio of the aggregate (projected) employment of the sample establishments at the target year; to the aggregate actual employment of the same establishments at the base-period. Assuming that whatever holds for the sample establishments holds also for other firms, the result of the operation is then aggregated to derive total requirements.[6]

EMPIRICAL USES OF THE SURVEY METHOD:

This method has been used in a number of countries. Such surveys have particularly been employed to forecast demand for technical and scientific personnel, e.g., engineers, physicians, and other high-talent manpower. This fact is mainly explained by the existence, in the case of technical and high-talent manpower, of an identifiable connection between the profession and a specific type of education, which facilitates forecasting work.

This approach has proved more useful in short-term (up to a year) rather than long-term forecasting.[7] The Canadian Department of Labour's EFS, which was started just after the Second World War, was designed to survey the opinions of the employers in various

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[2]See further below for a brief description of EFS.

[3]See D. G. Hartle; Employment Forecast Survey, Toronto, University of Toronto Press, 1962, Table II, p. 13.

[4]See further below for a brief description of this survey.

[5]See D. M. Blank and G. J. Stigler; The Demand and Supply of Scientific Personnel, National Bureau of Economic Research, 1957, table 16, p. 38.

[6]For a simple mathematical illustration of this method, see Hartle, op. cit., pp. 14-16.

[7]See the editorial article "Technical and Scientific Personnel: Methods of Assessing Supply and Demand," International Labour Review, vol. 81, 1960, pp. 58-73.

manufacturing and non-manufacturing sectors regarding short-term future employment conditions. More specifically, the questionnaire sent out by the Department requested the selected firms to indicate their total number of current employees (salaried and wage-earners) and to forecast their personnel requirements three and six months ahead.[8] The Professional Manpower Bulletin Series (changed to Reports in September, 1962) also provides information, based on annual sample surveys of the Scientific and Technical Personnel Register of the Department of Labour, concerning employment outlook for technical and scientific personnel in the near future.[9]

The U.S. Bureau of Employment Security's "Employers' Forecasts of Labor Requirements" provides bi-monthly reports regarding future manpower requirements, classified by occupational categories, in each of the selected industries in a number of regional labour markets.[10]

The questionnaire study conducted by the U.S. Engineers' Joint Council during 1952-4 simply asked the employers to state the number of engineers they actually expected to hire during the following year.[11]

EVALUATION OF THE EMPLOYERS' SURVEY METHOD:

This method has certain advantages; e.g., surveys can be made at regular or fairly frequent intervals and thus information about future labour market conditions may be kept reasonably up-to-date. The knowledge of each employer regarding his current personnel situation as well as his plans for future recruitment and staff changes is utilized. Moreover, the effect of this approach is to diffuse a considerable part of the responsibility for the forecast amongst employers: in this way, the forecasting agency does not have to face the difficult task of quantifying the probable magnitude and nature of technical change and its effect on labour productivity during the forecasting period.

However, it also possesses a number of practical problems. First of all, forecasting personnel requirements scientifically at the firm level is a recent development, and the number of firms actually practising it, is relatively small .[12] Secondly, some firms included in the sample may not respond because they may be unwilling to co-operate, unable to estimate their personnel requirements, or simply because they may wish to refrain from making any statements appearing as commitments; the result in such cases is that the sampling process remains

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[8]For a full list of the industrial classification used see Hartle, op. cit., pp. 111-112. There is a sample of the EFS 'shuttle' card on p. 118.

[9]See Bulletins Nos. 5 and 8, and Report No. 13 of the series published by the Economics and Research Branch, Department of Labour, Ottawa.

[10]See BLS' bi-monthly reports in the bulletin Labor Market and Employment Security.

[11]See Blank and Stigler, op. cit., Appendix H.

[12]For techniques of forecasting at the firm level see: I. B. Wadel and C. H. Bush, "An Approach to Probabilistic Forecasting of Engineering Manpower Requirements," I.R.E. Transactions on Engineering Management, vol. 8, 1961; and K. S. Packard: "Probabilistic Forecasting of Manpower Requirements," same journal, vol. 9, 1962.

defective. Thirdly, there will almost invariably be errors contained in the replies due to faulty or subjective interpretations of questions, terms and definitions, particularly if the questionnaire is not very explicit and straightforward. Fourthly, it is quite impossible for individual employers to foresee and evaluate correctly the effects of technological change on their business. Also, some of the existing firms may go out of business and new firms may enter the industry during the forecast period, especially if this period is long, so that the coverage and reliability of the sample may suffer. Finally, errors may arise from the failure of employers to distinguish carefully between gross and net estimates of requirements, and to make correct allowances for inter-firm mobility of labour.

For these reasons, some manpower planning agencies do not consider the survey method as a sound way of manpower forecasting. In Australia, for instance, this method is deliberately avoided.[13]

EFFORTS IN DIFFERENT COUNTRIES TO OVERCOME SOME OF THESE DIFFICULTIES:

Nevertheless, in certain countries special steps have been taken to overcome these difficulties and to increase the reliability of the surveys making them a more effective tool of manpower forecasting.

In Sweden, for example, the Committee of Technicians of the Swedish Association of Industries carried out in 1955 a questionnaire inquiry concerning the present distribution and future requirements for several types of technical and scientific personnel in the public and private sectors of the economy. In order to formulate the questions in as clear a fashion as possible, a few copies of the proposed questionnaire were sent, in the pilot stage, to a small number of selected firms and agencies. In the light of the difficulties observed, certain analytic and stylistic modifications were made in the final version of the questionnaire. Nevertheless, the results proved to be unreliable because it was impossible to obtain the full co-operation of several of the firms approached. In the end, it was assumed that the existing distribution of engineering and technical personnel would remain constant from 1955 to 1975.[14]

In France, employment forecasting by surveys is used to supplement other forecasting techniques, and special care is taken to make sure that the firms approached specify not only their employment but also their production forecasts. It is considered that if this is not done, the employment figures alone are unusable since the production assumption from which the employment forecasts were explicitly or implicitly derived, will not be known. If, on the other hand, production

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[13]See "Technical and Scientific Personnel: Methods of Assessing Supply and Demand," International Labour Review, vol. 81, 1960, pp. 58-73.
[14]See OECD; Forecasting Manpower Needs for the Age of Science, Paris, 1960, p. 55; also, OECD; Policies for Science and Education: Country Reviews: Sweden, 1962, p. 20.

forecasts are made explicit, then the planning agency can compare it against manpower forecasts to ensure internal consistency.[15]

CONCLUSIONS:

On balance, the following remarks seem pertinent. The difficulties and limitations of the survey method, as a technique for forecasting long-term manpower requirements, outweigh its merits to an extent of rendering such forecasts highly dubious. As a short-term forecasting tool, it provides useful information regarding conditions in the labour market in the near future. The degree to which training and education programmes will be influenced in the light of future manpower requirements forecast by the survey method is practically nil. Thus, as Harbison and Myers argue, forecasts made by individual establishments are essentially part of an assessment of the present situation rather than a practical means of making long-run forecasts.[16]

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[15]See the article by C. Vimont in OECD Study Group in the Economics of Education; Economic Aspects of Higher Education, Paris, 1964, p. 229.

[16]Education, Manpower and Economic Growth, Strategies of Human Resource Development, McGraw-Hill Book Co., 1964, p. 196.

chapter six

FORECASTING SPECIALIZED MANPOWER REQUIREMENTS

BY specialized manpower we mean manpower in medical, technical, scientific, teaching and other high-talent professions, which normally require university training. The fact that these professions are uniquely related to a specific educational background is fundamental from the point of view of forecasting requirements for such personnel. This relationship renders such forecasts relatively straightforward since the future supply of high-talent manpower is principally the function of the number of graduates from the relevant institutions of higher learning. Adjustments must be made in the cases of losses due to deaths, retirements, withdrawals from the profession, transfer to other occupations, and international and inter-regional migration.

In this chapter, we propose to consider a number of methods for forecasting (1) medical, (2) technical and scientific, and (3) teacher manpower requirements.

PHYSICIAN REQUIREMENTS:

The test of assessing the adequacy of physician manpower may be conducted either on the basis of the 'need' for medical care regardless of economic considerations, or alternatively, from the point of view of efficient allocation of economic resources (including human resources) amongst alternative uses. The 'need' criterion, in the form of a physician-population ratio, has customarily been the approach used; however, with the increased interest of theoretical economists in the problems of utilization of human resources, there is a growing tendency to devote more thought and study to the economic implications of future requirements of medical manpower.[1]

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[1]See, G. V. Rimlinger and H. B. Steele; "An Economic Interpretation of the Spatial Distribution of Physicians in the U.S." The Southern Economic Journal, vol. 30, (July, 1963), No. 1, pp. 1-12; H. E. Klarman: "Requirements for Physicians, Economics of Medical Care," The American Economic Review, vol. 41 (May, 1951), No. 2, G. W. Bachman: "Method of Measuring Physician Requirements with Appraisal of Former Methods," Journal of the American Medical Association, vol. 158 (June 4 1955), pp. 375-81; State of Israel Ministry of Labour, Manpower Planning Authority, Manpower Report: Doctors in Israel, Present Characteristics and Projections to 1970, May, 1964, by Herbert Smith. On Canada, see G. C. Clarkson, "Future Requirements for Physicians in Canada", Canadian Medical Association Journal, vol. 85, (November 18, 1961), No. 21, pp. 1162-69; S. Judek, Medical Manpower in Canada, Royal Commission on Health Services, 1964, chapter 8; Bruce A. McFarlane, Dental Manpower in Canada, Royal Commission on Health Services, Ottawa, 1964.

The assumption in this section is that while no person should be denied good and adequate medical care for economic reasons, nonetheless, forecasts of medical manpower should, as far as possible, be in conformity with the principle of optimal resource allocation. A reasonable way of translating this into an operationally feasible method would be: first to project medical manpower requirements solely on the basis of 'need' (using an acceptable physician-population ratio); then derive an alternative estimate of requirements solely on the basis of the relevant economic considerations; and finally to obtain an optimal estimate by comparing the two forecasts and also bearing in mind a scale of national priorities for the effective utilization of resources and manpower.

FORECASTING PHYSICIAN REQUIREMENTS ON THE BASIS OF 'NEED':

The following methodology may be used:

(i) obtain the number of active physicians in the base year, i.e., the current stock, and the total population in the same year, and derive the number of persons per physician;

(ii) get the projected population in the prescribed target-year;

(iii) on the basis of international standards or on the grounds of medically desirable health criteria, make an explicit assumption regarding the desirable ratio of persons per physician in the target-year. Needless to say, the assumed ratio must be feasible in terms of facilities (actual and planned) in medical schools, hospitals, equipment, etc.;

(iv) divide the projected population in the target-year by the assumed ratio to get the level of the required stock;

(v) make allowances for withdrawals (due to deaths, retirements, and international and inter-regional migration of physicians during the forecast period). The calculation of withdrawals may be derived as follows: If the present age distribution of physicians is known, deaths may be estimated on the basis of mortality rates in the various relevant age-groups. Estimates of retirements may be made from relevant available data (perhaps obtainable from medical associations). International and inter-regional movements may be worked out from migration statistics;

(vi) total requirements in the target-year are given by the following simple equation:

$$R=P-S+W$$

where R = the required total number of entrants to the ranks of physicians;

P = required stock in the target-year;
S = stock in the base-year; and
W = estimated withdrawals during the forecast period.

The above process gives us the required number of entrants to the ranks of physicians. To compare this figure with supply from medical schools and other sources of supply, in order to predict possible shortages or excesses, we proceed as follows:

(i) On the basis of the existing facilities in the medical schools, and recent entrance and graduation rates, estimate the total number of new physicians expected to qualify during the forecast period;

(ii) estimate and allow for withdrawals and migration amongst expected new entrants;

(iii) add the survivors of the current number of physicians to the new entrants to the profession to arrive at an estimate of supply at the target-year;

(iv) comparing this figure with the earlier figure for requirements, we can derive the magnitude of shortages or excesses, if any, of physicians in the target-year.[2]

EFFECTIVE DEMAND METHOD FOR ESTIMATING REQUIREMENTS —

(i) THE WORK-LOAD METHOD:

One rather simple way of computing effective demand for physician services, as opposed to the non-effective demand (i.e., need) approach outlined above, is to use the physician work-load method.[3]

The major assumption of this method is that the volume of physician services as measured by the number of non-hospital visits per private physician, (quite regardless of the quality of service rendered), can be taken as a sufficient and reliable index of the demand for physician services. Therefore, the problem resolves into the computation of the number of non-hospital visits per private physician. Using this criterion as the indicator of future requirements, it is possible to estimate future physician manpower levels. Judek[4] has actually used this method to estimate requirements for physicians in private practice, for Canada and Provinces in 1961.

In the case of forecasts of hospital physicians, future requirements may be derived on the basis of hospital discharges per physician, patient hospital days per physician or any other reasonable criterion of physician hospital work-load.

EVALUATION OF THE WORK-LOAD METHOD:

The main criticism of this method is that visits to physicians, considered as the measure of demand for physician service, is too restrictive an assumption. The reasons why people go to doctors are

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[2]This is the method suggested by H. S. Parnes, Forecasting Educational Needs for Economic and Social Development, OECD, Paris, 1962, pp. 42-4.

[3]See: G. W. Bachman, op. cit., pp. 375-381; S. Judek, op. cit., pp. 255-7; G. V. Rimlinger and H. B. Steele, op. cit., pp. 8-10.

[4]Judek, op. cit., p. 256, table 7-3.

positively related to income and to a complex set of socio-economic factors, such as the perception of illness, easy access to physicians, the economic value of good health to the patient, possession of health insurance, age, sex and so on. It is doubtful whether the actual number of visits during a period of time adequately reflects the real demand for medical service.

EFFECTIVE DEMAND METHOD FOR ESTIMATING REQUIREMENTS:

(ii) AN ALTERNATIVE METHOD:

An alternative method to forecast future private physician requirements is to make use of the fact that at any given period of time the number of practising private doctors is equal to the aggregate economic value of private physician services divided by the average earnings per physician per period of time. In terms of an equation:

$$N = \frac{(a\,b\,Y)\,p}{y}$$

where N = number of physicians, a = proportion of national income per capita spent on the average visit to the physician, b = the number of visits per person per period of time, Y = national income per capita, y = average earnings per physician per period of time, and p = population.

To find N at the target-year, we need to know the projected population and national income per capita in that year; secondly, we need to make an assumption concerning expected changes in the values of a and b; and finally, we have to estimate, on the basis of past trends, the average growth of earnings per physician during the forecast period.[5]

EVALUATION OF THIS METHOD:

The fundamental criticism of this approach is that it deduces requirements from the number of visits to physicians and income per capita, and thus, it relies on ability to pay for physician services. As mentioned above, this is not a very satisfactory index. However, it might be useful to use this approach and compare the result with the result obtained by means of the physician-population ratio approach. If the physician-population ratio approach is used to forecast requirements, it will be found that, in our hypothetical example (assuming a constant ratio), physicians required will be 5,500 and not 5,280. The final determination of requirements, somewhere between these two limits, may be derived according to a system of national priorities for the effective utilization of manpower and economic resources.

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[5]To give a hypothetical illustration, suppose that in the base-year a=0.1%, b=20, Y=$4000, P=500,000 and y=$8000 then it follows that N=5,000. Now, if we are given that in the target-year, a and b will be tne same as in the base-year, Y will be 20% higher, p 10% greater, and y 25% higher, then the requirements for private physicians will be 5,280.

FORECASTING TEACHER REQUIREMENTS:[6]

The ideal method of estimating future teacher requirements is to derive the skilled and trained labour requirements from national income or output targets, and then deduce the relevant teacher requirements on this basis. This implies no more than comparing, (as in the chapter on the productivity method),[7] the supply of graduates from the existing educational institutions with skilled labour requirements. If there is a possibility of 'shortage' or 'surplus' in some skills, then educational programmes must be adjusted accordingly and teacher requirements must be estimated in the light of this adjustment. This requires flexibility in educational planning, but it is an effective way of ensuring a dynamic balance between the educational system and the manpower needs of the economy.

THE CONVENTIONAL METHOD — STUDENT/TEACHER RATIO:

The conventional method for estimating teacher requirements[8] calculates (i) the change in the number of enrolments; (ii) the progressive improvement of the student/teacher ratio; (iii) losses due to deaths, retirements, withdrawals; and (iv) international and inter-regional migration of teachers.

EVALUATION OF THE CONVENTIONAL METHOD:

The trouble with this approach is that, because it is used quite independently of the skilled and trained manpower requirements of the economy, it may result in structural imbalances between the educational outflows and the effective demand for skilled and trained manpower. Consequently, there may be misallocation of resources and an "intellectual unemployment". An eminent American economist, S. E. Harris[9] has argued that, in America, there would soon be a general over-supply of educated persons causing such an "intellectual unemployment."

EVALUATION OF DERIVED TEACHER REQUIREMENTS METHOD:

The method of deriving teacher requirements from national income or output targets is, to be sure, open to criticism. The major charge is that the margin of error in income or output projections is so great that it would be dangerous to base major educational reforms upon these projections.[10]

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[6]Educational needs for cultural or citizenship purposes, while of great importance, are not examined in this section. It is understood, however, that the manpower planners take due account of these considerations.

[7]See p. 18.

[8]H. S. Parnes, pp. 44-5; M. G. Steward: "A New Look at Teacher Requirements", Monthly Labour Review (U.S.A.), vol. 87 (June, 1964), No. 6.

[9]OECD Study Group in the Economics of Education; Economic Aspects of Higher Education, Paris, 1964, p. 67.

[10]OECD: Critical Evaluation of the First Stage of the Mediterranean Regional Project (mimeographed), Paris, 1965, chapter 3.

This is a valid criticism. At the present, our ability, as forecasters, to project output and manpower levels to some prescribed year in the future is limited by the unquantifiability of technical change and economic prospects.

But, for long-run educational planning purposes the derived teacher requirements method is certainly very helpful.

SCIENTIFIC AND TECHNICAL PERSONNEL REQUIREMENTS:

There are a number of methods for forecasting scientific and technical manpower requirements.

The Blank and Stigler Method: This method[11] involves an elaborate and quantitative investigation of various factors influencing the demand for, and supply of, certain types of skills, such as engineers, teachers, chemists, etc. Blank and Stigler have examined patterns and trends in the employment of these professionals, the effect of changing employment weights, and the upward trend of demand for professional manpower as a group, in order to deduce the future patterns of demand for such high-talent manpower. On the supply side, an extensive study of the composition, volume and patterns of college-trained personnel was undertaken; earnings of each type of profession were studied in detail.

A somewhat similar analytical approach was used by the U.S. Dept. of Labor, BLS in the studies: *The Long-Range Demand for Scientific and Technical Personnel: A Methodological Study*[12] and *Scientists, Engineers and Technicians in the 1960's, Requirements and Supply.*[13]

The main defect of this approach is that it can only give us an impressionistic view concerning future trends and prospects: we are unable to inter-relate the several factors affecting supply and demand in the final determination of future requirements and supply.

THE SURVEY METHOD:

As was mentioned in the chapter on the employers' survey method,[14] it is popular to carry out a questionnaire survey among a sample of firms employing professional manpower in order to ascertain the level of future demand for such manpower. Such surveys are carried out by the Canadian Federal Department of Labour, the Swedish Federation of Industry, and various other countries.[15]

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[11]Blank and Stigler, The Demand and Supply of Scientific Personnel, National Bureau of Economic Research, 1957.

[12]Ref. No. NSF 61-65, U.S. Gov't. Printing Office, 1961.

[13]Ref. No. NSF 63-34, U.S. Gov't. Printing Office, 1964. These two studies were prepared for the National Science Foundation.

[14]See Chapter V.

[15]References in the Chapter on the Employers' Survey Method.

EXTRAPOLATION METHOD:

Another popular method is to extrapolate past trends between the number engaged in a professional manpower category and a reasonable economic index, such as the total employment in the appropriate sector or industry, national income, production, etc. This is a particular application of the trend projection method discussed in this study.[16]

If, instead of forecasts of requirements for one or few professional categories, it is desired to forecast requirements for a large number of categories, then it may be best to use an industry by occupation matrix. After setting up the form of the matrix (e.g., industries vertically and occupations horizontally), the first thing to do is to compute the position in the base-year. Then, in the light of the results of an employers' survey[17] or of findings of empirical studies concerning occupational patterns and trends,[18] the base-year figures may be adjusted for the target-year.

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[16]See Chapter IV.

[17]This was the method used in U.K. Advisory Council on Scientific Policy, Committee on Scientific Manpower, Scientific and Technological Manpower in Great Britain, 1962, 1963. Cmnd. 2146. See particularly tables 1-13 at the end of the report.

[18]This method was used in Sweden in 1960 to project demand for engineers and technicians to 1980. See S. Olof-Doos, in Employment Forecasting, OECD, Paris, 1962, particularly p. 36 et. sq.

chapter seven

INTER-AREA COMPARISONS METHOD

INTER-AREA comparisons (i.e., international and/or inter-regional comparisons) have two uses in manpower planning: in the first place, they enable the reporting country or region to assess its present manpower policies and inventory in relation to other comparable economies; and secondly, (especially in the absence of sufficient data) they can be employed as a general method for forecasting manpower requirements.

In this chapter, we shall primarily be concerned with inter-area comparisons as a technique for forecasting manpower requirements. However, it should be noted that a comparison of the past and present manpower situation of one country with that of other countries is of great aid to manpower planning agencies trying to formulate a manpower strategy for the future.[1] These comparisons are particularly revealing in the case of trends in output per man-hour, educational attainments of specific occupational categories, distribution of the total labour force amongst sectors and occupations, participation rates and so on.

EXAMPLES OF INTERNATIONAL COMPARISONS:

In some countries, forecasts of specific occupational manpower requirements with appropriate educational attainments have been made using the international comparisons method.

Two examples where this approach has been used are Puerto Rico[2] and Italy.[3]

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[1]The most comprehensive recent study using the comparative approach in an international perspective is F. Harbison and C. A. Myers; Education, Manpower and Economic Growth: Strategies of Human Resource Development, New York, McGraw-Hill series in International Development, 1964. For OECD countries, see: OECD, Resources of Scientific and Technical Personnel in the OECD Area, Paris, 1963, which contains a great mass of statistical data regarding the member countries.

[2]Committee on Human Resources; Puerto Rico's Manpower Needs and Supply, San Juan, 1957.

[3]SVIMEZ; Trained Manpower Requirements for Economic Development of Italy—Targets for 1975, Rome, 1962.

The purpose of the Puerto Rican study was to forecast the distribution of the labour force in the target-year 1975 by occupational categories and by appropriate educational attainments. Since there was a dearth of necessary statistical data, it was decided to emulate productivity trends in the United States making allowances for the difference in the level of economic development of the two countries. Starting from the assumption that "to achieve equivalent levels of productivity parallel occupation groups in two economies must have equivalent educational characteristics",[4] it was decided to use the educational qualifications of the occupational categories in the U.S.A. for 1950 as targets for the Puerto Rican counterparts in 1975.

In the Italian case, sectoral manpower requirements were obtained by means of an assumption that the Italian productivity of each sector (except agriculture) in the target year 1975 would reach the level attained in France in 1960.[5]

EVALUATION OF THE INTERNATIONAL COMPARISONS METHOD:

The fundamental assumption of this method is that economic development in different countries proceeds through similar stages of growth. Although some economists think this is a reasonably valid hypothesis, there is considerable disagreement with this view. However, it is more generally agreed that there is a stable and positive relationship between the level of educational attainment and economic development.[6]

Great caution must be exercised when making international comparisons. It would be highly misleading to rely solely on published statistical data; it is necessary to consider the social and economic background of other countries. International comparisons are meaningful only in the cases of those countries which have similar general social and economic structures. Also, it is advisable to scrutinize the methods and sources of data referring to other countries in order to ensure that they are valid in every respect.

Harbison and Myers have classified 75 countries into 4 divisions by levels of "human resource development index"[7] for the purpose of facilitating the comparability of conditions of countries. Though this classification is by no means free of conceptual and practical problems, nevertheless, it enables the derivation of general guide-posts to be used for estimating occupational manpower requirements. This can be done by taking, as targets, the present position of a country in a higher

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[4]Puerto Rico study, p. 32.

[5]The SVIMEZ study; also see M. Debeauvais in Planning Education for Economic and Social Development, ed. H. S. Parnes, OECD, Paris, 1962, p. 90.

[6]See, S. Kuznets; Economic Development and Cultural Change, supplement, vol. 5 (July, 1957), No. 4. Also, Harbison and Myers, op. cit.

[7]Harbison and Myers, op. cit., p. 32 and table 1, p. 33.

division than the reporting country. These results will be highly questionable, but they might serve as a useful starting point for further research and refinement.

PROBABILITY OF USE OF THE INTER-AREA COMPARISON METHOD IN ONTARIO:

In the case of Canada generally, and the Province of Ontario particularly, great benefit might be derived from looking closely at the American scene. Many American states put out good forecasts of their skilled and unskilled manpower requirements.[8] It would be very interesting to compare and contrast the retrospect and prospect of Ontario with some of the more advanced American states, as indeed, it would be very revealing to do the same exercise with other Canadian provinces.

[8]See N.Y. State Dept. of Labour, Division of Research and Statistics; Projecting New York State Job Patterns: A Technical Supplement to "Jobs 1960-1970", January, 1961. W. Haber, F C. McKean and H. C. Taylor; The Michigan Economy: Its Potentials and its Problems, Kalamazoo, Mich. The Upjohn Institute for Employment Research, 1959.

chapter eight

ELASTICITY OF FACTOR SUBSTITUTION METHOD

IT has been well observed by a leading economist "that the manpower projections I know about have not succeeded in taking account of the elasticity of substitution between capital and labour and between highly-trained manpower and less-highly trained manpower".[1] The elasticity of factor substitution method is a tentative method designed to tackle this problem.

It is included in this study more for the sake of completeness than for its practical usefulness, which is very limited at the present stage of development. But, this method is becoming increasingly popular with theoretical economists[2] and it is hoped that before too long it may become reasonably practical. If and when this should be achieved, the method may yield highly refined forecasts of specific skill requirements, and it may do so by incorporating the effects of technical change on factor proportions in a reasonably effective manner.

THE BASIC HYPOTHESIS:

The basic hypothesis of the elasticity of factor substitution method is that dynamic change in relative factor prices is the result of technical innovation. These factor price changes have the effect of causing shifts in the factor proportions of particular production functions such that the relatively cheaper factors are substituted for the relatively expensive ones. Thus, by studying the past trends of factor substitution and by evaluating future prospects in factor markets, it might be possible to predict the nature of shifts in relative factor propor-

[1]W. G. Bowen; Economic Aspects of Education, Princeton, Industrial Relations Section, Princeton University, 1964, p. 35.

[2]K. Arrow, H. Chenery, B. Minhas and R. Solow; "Capital-Labor Substitution and Economic Efficiency," Review of Economics and Statistics, vol. 43, (August 1961), pp. 225-50. H. Chenery; "Patterns of Industrial Growth," American Economic Review, vol. L (September, 1960), no. 4. J. R. Minasian; "Elasticity of Substitution and Constant Output Demand Curves for Labor," Journal of Political Economy, vol. 49 (June 1961). G. Ranis; "Factor Proportions in Japanese Economic Development," American Economic Review, vol. 48 (September 1957), no. 5. R. G. Hollister; "Economics of Manpower Planning," International Labour Review, vol. 89 (April 1964), no. 4.

tions. Once the factor proportions in the target-year are known, the only other piece of information needed to derive manpower requirements is the level of output in the target-year.

THE ASSUMPTIONS:

It may be useful to enumerate the kind of assumptions on which the theory rests:

It is, first of all, assumed that relative factor prices change only with technical innovation and advance; short-term price fluctuations in factor markets resulting from temporary changes in supply and demand conditions are not considered.

Secondly, it is assumed that the extent and bias of technical innovation during the forecast period can correctly be predicted and quantified.

Thirdly, it is assumed that we can safely disregard the effect of time lag between an invention and its utilization by firms; it is considered that entrepreneurs are able and willing to benefit from technical change automatically.

Finally, it is assumed that payments to factors of production just exhaust the value of the total product.

EVALUATION OF THE METHOD:

These are, clearly, highly questionable assumptions. In addition, the kind of data required is often very difficult to get, if not outright impossible.

However, research in this field has produced some promising results. For example, H. Chenery discovered, as a result of studying the development of 51 countries that "supply changes (resulting from a change in relative factor costs) are more important in explaining the growth of industry than are changes in demand (resulting from income changes)".[3] If supply changes may be considered as technologically-determined, this result is encouraging from the point of view of the usefulness of the elasticity method. One condition in which supply changes would be the result of technical change is when the elasticity of substitution for skill is low. Therefore, a low elasticity of substitution for skill is desirable from the point of view of manpower forecasting. It is not desirable insofar as economic development generally is concerned, since a low elasticity of factor substitution implies that production techniques may change only with shifts in product-mix rather than shifts in input-mix.

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[3]H. Chenery; "Patterns of Industrial Growth," American Economic Review, vol. L (September 1960) no. 4, p. 644.

W. E. G. Salter's study[4] shows that, while it would be misleading to suggest that increased labour productivity is solely, or even largely, due to factor substitution, yet it is possible to calculate the proportion of increase in total labour productivity attributable to substitution between labour and capital. Salter himself calculates[5] that something of the order of 26% to 40% of the total increase in labour productivity in the United Kingdom during 1924-50 was due to the substitution of capital for labour.

It might also be mentioned that various empirical studies have proved that generally speaking, the entrepreneur is quite responsive to changes in relative factor prices and endeavours to make adjustments in his production techniques in order to take advantage of the relatively cheaper factors.[6]

Finally, it seems plausible to assume, at least for some professions, that the elasticity of substitution for high-level skills is quite low.[7]

These encouraging tendencies and evidences are, however, insufficient to overcome the conceptual and practical difficulties pertaining to the technique. Only after further research and more conclusive results can it be considered as a practical tool of the manpower forecaster. In particular, it is necessary to undertake empirical surveys to determine the magnitude of the elasticity of substitution for skills in various productive processes. It is also important to endeavour to formulate a conceptual and practical way of disentangling supply changes due to short-term market fluctuations, from those long-term price movements occurring because of technological growth.

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[4]W. E. G. Salter; Productivity and Technical Change, Cambridge, University of Cambridge, 1960. (Department of Applied Economics Monographs No. 6.)

[5]Ibid. Table 22, p. 139.

[6]See, Minasian; "Elasticity of Substitution and Constant Output Demand Curve for Labor," op. cit., p. 270. Ranis; "Factor Proportions in Japanese Economic Development," op. cit., pp. 594-607.

[7]Hollister "The Economics of Manpower Planning", op. cit., p. 385.

chapter nine

CO-ORDINATING EDUCATIONAL PLANNING WITH MANPOWER FORECASTING

IN this chapter a problem central to all kinds of manpower forecasts will be discussed: the optimal co-ordination of the educational system of the society with the qualified manpower needs of the economy.

VARIOUS ASPECTS OF THE PROBLEM:

This is a many-sided and complicated problem. Some of its various aspects may be mentioned as follows: (i) the problem of translating 'crude' labour requirements, as derived through some appropriate forecasting technique, into qualified labour requirements, and then deriving the appropriate educational requirements; (ii) the problem of optimum allocation of investment resources, which invariably are in limited supply, between education and other investment channels; and (iii) the problem of keeping the right balance between one branch of education and another, especially between 'general' and 'vocational' types.[1]

These problems are very important, but, of course, they cannot all be discussed here. In fact, only the first one will be considered since it is the one most directly connected with manpower forecasting. On problem (ii) reference should be made to the writings of the Chicago economists.[2] Regarding consideration of (iii) Tinbergen, Bos and Correa[3] should be consulted.

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[1] A somewhat different problem is that of maximizing the economic return to a given amount of scientific or trained talent by allocating it optimally between different alternative productive uses. On this subject, see V. Stoikov; "The Allocation of Scientific Effort: Some Important Aspects" The Quarterly Journal of Economics, vol. 78 (May 1964), no. 2, pp. 307-23. For a different aspect of the same problem, see; I. Horowitz; "The Regional Distribution of Scientific Talent," The Southern Economic Journal, vol. 31 (January 1965), no. 3, pp. 238-50.

[2] T. W. Schultz; The Economic Value of Education, Columbia University Press, 1963; G. S. Becker: Human Capital: A Theoretical and Empirical Analysis with Special Reference to Education, National Bureau of Economic Research, New York, 1964; papers in Journal of Political Economy, vol. 70, Supplement. (October 1962), no. 5, part 2.

[3] Tinbergen and Bos; Econometric Models of Education, OECD, Paris, 1965: Correa; "Optimum Choice between General and Vocational Education," Kyklos, vol. 18, 1965, Fasc. 1.

PROBLEMS OF TRANSLATING MANPOWER ESTIMATES INTO EDUCATIONAL REQUIREMENTS:

This is a major task having serious conceptual and practical difficulties. To begin with, there are numerous job categories, especially the blue-collar ones, which do not have a specific educational or training background. In such cases, it is impossible to devise a stable correlation between the job and educational training and derive therefrom precise quantitative yardsticks for educational and training programmes in the light of manpower requirements. Additionally, such job categories are marked by a significant amount of inter-job transfers and mobility, which is very difficult to estimate and predict. Similarly, intra-job promotions and demotions are not easily quantifiable.

Secondly, the years of formal schooling, as indices of educational attainment, provide only a rough measure of educational content and quality of schooling, and as such, cannot satisfactorily reflect the quality of education received. Also, formal subjects taken at school may only partially or never be used in a professional capacity.

Finally, many executive jobs, e.g., managerial positions, do not have particular educational qualifications. An engineer, physician, or other professionals may, at one time or another, come to occupy positions unrelated to their formal training. Consequently, the forecaster is faced with major problems of inter- and intra-occupation mobility, job definition, and job and education correlation.

The conclusion is that it is not always possible to derive clear-cut correlations between manpower requirements and the implications thereof for education and training programmes. Because of this fact, a number of manpower planning agencies are content to simply point out in general terms, the main areas of 'crises'; no attempt is made to derive precise occupational details.

Clearly, this type of approach is not very helpful. It is argued here that so long as some sacrifice from precision and certainty can be made in exchange for forecasts of specific occupational requirements by appropriate educational training, it is possible to derive educational requirements. Then certain adjustments can be made, if need be, in the current education system with a view to achieving equilibrium between supply and demand in occupational labour markets in the target year.

ATTEMPTS TO QUANTIFY RELATIONS BETWEEN OCCUPATIONS AND EDUCATION AND TRAINING:

(i) THE ECKAUS APPROACH:

R. Eckaus[4] has attempted to quantify the educational and training levels of the U.S. labour force of 1950 by branch of economic activity.

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[4] "Economic Criteria for Education and Training," The Review of Economics and Statistics, vol. 46 (May 1964), no. 2, pp. 181-90.

The basic evaluations of educational levels for specific job categories considered are obtained from the U.S. Department of Labor, BLS publication: *Estimates of Worker Trait Requirements for 4,000 Jobs,* which indicates the "General Educational Development" (GED) levels and the "Specific Vocational Preparation" (SVP) required for the average performance for a sample of 4,000 jobs in the U.S.A. The GED categories are classified into seven classes on the basis of school years, ranging from "0 school years" for GED category 1 to "18 school years" for GED category 7. The SVP categories are arranged into nine divisions on the basis of training time, which ranges from "short demonstration only" for SVP division 1 to "over ten years" for SVP division nine.[5]

As an illustration, the total labour force of 1940 and 1950 are classified on the basis of the GED and SVP categories.[6] A comparison of 1950 with 1940 shows that both for the GED and SVP categories there has occurred a general upgrading of the educational and training attainment of the labour force.

Finally, Eckaus applies the GED and SVP categories to sectoral occupational divisions, using the distribution of the 1950 labour force. He derives for each occupational division the average number of years of schooling and the amount of vocational training actually possessed.[7]

The novelty and usefulness of this approach stems from the fact that by differentiating between various types and durations of education and training and using them to estimate the average educational and vocational level of each occupational category, a reasonably refined relationship between education and training on the one hand, the occupational categories on the other, can be established; this relationship can then be used to derive the target-year educational and training requirements.[8]

(ii) THE OECD APPROACH:

The OECD approach to the derivation of educational qualification of workers in selected occupational categories is summarized in Appendix D[9] of H. S. Parnes: *Forecasting Educational Needs for Economic and Social Development*, Paris, 1962. The method is to divide the total labour force into major occupational categories such as professional, administrative, skilled and unskilled personnel, and then work out the years of schooling obtained for each category. Moreover, years of schooling obtained is also worked out for a number of selected specific occupations like physicians, lawyers, accountants, nurses and so on.[10]

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[5]Ibid., tables 1 and 2.

[6]Ibid., tables 3 and 4.

[7]Ibid., table 5.

[8]Recently, B. W. Wilkinson has used this method to estimate the educational requirements of the Canadian labour force. See, chapter 5 of his unpublished Ph.D. Thesis; Some Economic Aspects of Education in Canada.

[9]Tables 1 and 2, pp. 108-111, contain data on Canada and a number of other countries.

[10]Ibid. tables 3 and 4, pp. 112-3.

(iii) THE PLATT APPROACH:

A somewhat similar approach has been offered by W. J. Platt.[11] The essence of this approach is the concept of "attainment coefficient", which is defined as the fraction of the labour force in a given sector occupation which possesses a prescribed level of education. For the purpose of analysis, education is differentiated into university, secondary and elementary levels, but analytically one can differentiate it as needed. Platt, then, constructs an occupation by type of education matrix[12] which shows the attainment coefficients at the base-year. Next, an explicit assumption is made for upgrading these coefficients in the light of expected technological change, requirements of employers, and international standards. The adjusted coefficients are the indexes of educational attainment in the target-year, and the actual trained manpower needs are directly computed from these figures.

(iv) AN INTERVIEW METHOD:

A less sophisticated but simpler method of tackling the problem is to interview a sample of leading or representative establishments in an industry in order to determine empirically the educational and training qualifications which employers will be demanding in the future. Questions will obviously centre around: (a) the educational qualifications of the present stock; (b) formal education or training qualifications which the hiring firms require; (c) opinions of the employers concerning the sufficiency of current educational and training programmes; and (d) opinions of the employers regarding ways and means of improving the training of future workers.[13]

(v) THE ECONOMETRIC MODELS OF TINBERGEN - BOS - CORREA:

An interesting approach to the problem under discussion is the attempt of Tinbergen, Bos and Correa to formulate a dynamic model to determine the optimal educational system necessary to permit the economy of a given country to grow at a prescribed rate of growth.[14]

The model was actually applied in three OECD countries: Greece, Spain and Turkey.[15] It was found, among other things, that there are too few third-level students (i.e., post-secondary) in Spain and Turkey, and possibly too many in Greece.

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[11]W. J. Platt; "Manpower Planning in Thailand". A paper presented to the Summer Conference on Educational Planning, Syracuse University, July 1964, (mimeographed).

[12]Ibid., table 3.

[13]H. S. Parnes; Planning Educational Needs for Economic and Social Development Paris, 1962, pp. 147-57.

[14]J. Tinbergen; "Quantitative Adaptation of Education to Accelerated Growth," Kyklos, vol. 15, 1962, pp. 776-86. H. Correa; "Optimum Choice between General and Vocational Education" Kyklos, vol. 18, 1965, pp. 107-113, and Economics of Human Resources, Amsterdam, 1963.

[15]J. Tinbergen and H. C. Bos; Econometric Models of Education, Some Applications, OECD, 1965.

The basic assumption underlying these econometric models of optimal education systems is that there is a reversible (i.e., two-way) linear relationship between education and economic growth so that by influencing one the other is also influenced. It is also implicitly assumed that ways and means can be found to induce the population to seek the desirable education as revealed by educational requirements of manpower forecasts.

These are, clearly, strong assumptions and the model has been severely criticized.[16] But experts at the OECD as well as various other educational centres are devoting more and more time and energy to make these models more practical and useful.

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[16]See T. Balogh; "Education and Economic Growth," Kyklos, vol. 17, Fasc. 2, 1964, pp. 261-72, where Balogh argues that "what Tinbergen has done is to assume the answers (he wished to obtain) and then put them into a simple mathematical form."

chapter ten

DATA REQUIREMENTS IN MANPOWER FORECASTING AND SOURCES OF DATA IN ONTARIO

THIS chapter is divided into two sections. In the first section, the data requirements of the various manpower forecasting methods are examined. In the second section, some of the main sources of data and statistical information most directly relevant to quantitative manpower forecasting in Ontario are explored.

DATA REQUIREMENTS OF VARIOUS FORECASTING METHODS:

Table I summarizes the data requirements on the assumption that all the required data are readily available. A comparison of this table with Table II below may indicate some of the major deficiencies and gaps in the availability of information in Ontario.

SOME SOURCES OF DATA IN ONTARIO:

Table II is a tentative attempt to explore the main sources of data and information for use in manpower forecasting in Ontario. It is by no means an exhaustive table. However, it is hoped that it may serve as a useful point of departure for quantitative research in manpower forecasting.

Sources of data are indicated in short-hand language. Full names and titles are to be found in the general Bibliography, which is arranged according to the seven methods.

TABLE I

Data Requirements of Various Manpower Forecasting Methods (Summary)

Employers' Survey Method	Econometric Method	Productivity Method	Trend Projection Method	Specialized Manpower Requirements	Elasticity of Factor Substitution Method
1 — Sample of firms.	1 — Inter-industry flows.	1 — Output per man-year.	1 — Time-series on labour force by major sector and occupations.	[illegible] present stock.	1 — Time-series on wage-rates and prices of non-labour inputs.
2 — Occupational structure of employment of the sample firms.	2 — Technical coefficients.	2 — Hours worked per man-year.	2 — Time-series on output by industrial origin.	2 — Enrolment in educational institutions.	2 — Factor proportions in terms of dollar values, for specific production functions.
3 — Occupational structure of aggregate employment of the sector.	3 — Skill coefficients.	3 — Output by industrial origin.	3 — Time series on the particular variables correlated — e.g., output, population, specific sectoral employment, specific occupational employment.	3 — Enrolment, graduation, and dropout rates.	3 — Information regarding the relative effects of supply and demand conditions on production techniques.
4 — Value of output of the sample firms.	4 — Information regarding factors influencing technical and skill coefficients.	4 — Labour force divided into sectoral and occupational categories.		4 — Population projections by age-sex groups.	4 — Nature of expected technical change.
5 — Aggregate value of output of the sector.	5 — Information regarding future final demand and nature of technical change.	5 — Future level of demand.		5 — Indicators of demand for services of specific professionals.	
6 — Information concerning future prospects.		6 — Expected change in hours worked per man-year.			
		7 — Expected change in output per man-year.			

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TABLE II

Data Available for Use In Various Manpower Forecasting Methods

(with special reference to Ontario)

Method	Description	Source	Date and Period (approx.)
I. ECONOMETRIC:[1]			
i. Inter-industry flows.	Statistical data and commentary.	DBS Study, Ref. Paper No. 72.	1949
	"	J. Sawyer's CJEPS article.	1949
	"	Caves and Holton, chapter 14.	1970
	Methodological.	Gigantes and Pitts.	1961
II. PRODUCTIVITY:			
i. Output by industrial origin.	Ontario.	W. Cameron.	1951, 61, 70.
	Federal and provincial.	The Howland Report, especially tables 3, 7, 8, 25-29.	1926-53
	Federal.	DBS: National Accounts, Income and Expenditure.	Annual
	"	N. M. Meltz: Changes in Occupational Composition, 1931-61, pp. 121-6.	By decades: 1931-61
ii. Labour force by industry and occupation.	Ontario.	W. Cameron.	1951, 61, 70
	Federal and Provincial.	The Howland Report, especially tables 4-7, 8, 22, 32, 33, 41, 42 and 55.	to 1955
	"	Hood and Scott, pp. 186-91.	1955-80
	"	DBS: Employment and Payrolls.	Monthly
	"	Caves and Holton, chapters 5, 6 and 20.	to 1951
	"	Census of Canada.	By decades
	"	DBS: The Labour Force.	Monthly

[1]There are no econometric models of the Ontario economy, but I understand that the Provincial Dept. of Economics and Development is currently embarking on the construction of an input-output table, which will not be ready for publication for some time yet.

METHOD	DESCRIPTION	SOURCE	DATE AND PERIOD (APPROX.)
ii. Labour force by industry and occupation. (Cont'd)	Federal and Provincial	DBS: Manufacturing Industries of Canada, Sections A-G.	Annual
	Federal.	Meltz, op. cit. Appendix A. Also, see his Occupational Trends in Canada, 1931-61, tables 1-6.	By decades: 1931-61
iii. Output per man-hour.	Federal	DBS: Indexes of output per person employed and per man-hour in Canada.	1947-63
	"	Hood and Scott, chapter 5 and Appendix to Chapter 5.	1926-55
(Real domestic product per worker).	"	Meltz: Changes in Occupational Composition, p. 88.	By decades 1931-61
(Net value of output per worker).	Provinces.	The Howland Report, especially tables 58-63.	1953
iv. Hours of work.	Federal and provinces.	Census of Canada.	By decades
	"	Various DBS bulletins.	Monthly/ annually
	Federal.	Hood and Scott, chapter 5 and Appendix to chapter 5.	1926-55
v. Future prospects.	"	Caves and Holton, chapter 9.	To 1970
	"	First Report of Economic Council.	To 1970
	"	The Drabble study.	To 1970
(Occupational distribution of full employment).	"	Meltz paper, Economic Council.	1970
III. TREND PROJECTIONS:			
i. Population projections	Federal and Provincial.	Census of Canada, 1961, vol. I, part 1-10.	By decades 1901-61
	"	Hood and Scott, chapter 4.	1951-80

METHOD	DESCRIPTION	SOURCE	DATE AND PERIOD (APPROX.)
i. Population projections (Cont'd)	Federal and Provincial	The Howland Report, p. 142.	1955-80
	"	Ostry, Denton and Kasahara, Economic Council Staff Paper, No. 1.	
ii. Labour force participation rates.	"	Census of Canada, 1961, vol. III, part I, bulletin 3.1-1.	1911-61
	"	Woods and Ostry, pp. 302-18.	1891-61
	Federal.	Hood and Scott, chapter 4.	1946-80
	"	Ostry, Denton and Kasahara, Economic Council Staff Paper No. 1 Also, see No. 3.	
iii. Labour force by major industries.	Federal and provincial.	DBS: The Labour Force.	Since 1946
	"	The Howland Report, especially tables 4, 5, 7, 8, 22, 32, 41 and 42.	To 1955
	Provincial.	Caves and Holton, tables 117-122.	To 1951
	Federal.	Hood and Scott, pp. 195-200, pp. 308-16 and Appendix 7-B.	1926-81
IV. EMPLOYERS' SURVEY:			
i Procedure and methodology.	Theory.	Studies by Hartle.	
ii. Occupational distribution of the labour force by major industries.	Federal and provincial.	DBS: Employment and Payrolls.	Monthly
V. SPECIALIZED MANPOWER:			
i. Short-term forecasts.	Federal.	Professional Manpower Bulletin Series, Fed. Dept. of Labour, Economics and Research Branch.	Since 1946
	"	Royal Commission's Report: Skilled and Professional Manpower in Canada.	1931-56

METHOD	DESCRIPTION	SOURCE	DATE AND PERIOD (APPROX.)
Specialized Manpower (Cont'd)			
ii. Medical manpower.	Federal and provincial.	Judek's study.	Various Time-series
iii. Dental manpower.	"	McFarlane's study.	Various Time-series
VI INTER-AREA COMPARISONS·	See the bibliography, section vi.		
VII. ELASTICITY OF FACTOR SUBSTITUTION:			
i. Capital-labour substitution in manufacturing.	Federal.	Kotowitz paper.	1926-61

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Plan of Bibliography

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II	*The Econometric Method:*	Items: 6, 7, 8, 9, 10, 11, 15, 29, 36, 37, 46, 48, 62, 68, 88, 128, 137, 144, 145, 148.
III	*The Productivity and Trend Projection Methods*	Items: 10, 14, 15, 18, 20, 22, 24, 25, 32, 40, 44, 51, 52, 53, 55, 58, 65, 72, 78, 79, 81, 82, 84, 85, 86, 87, 89, 93, 98, 102, 103, 105, 109, 111, 112, 120, 130, 132, 138, 139, 140, 142, 143, 151, 152.
IV	*The Employers' Survey Method:*	Items: 3, 16, 19, 35, 47, 66, 99, 100, 130, 131, 132, 136, 146, 147.
V	*The Specialized Manpower Requirements Method:*	Items: 3, 6, 24, 25, 34, 39, 57, 61, 63, 70, 74, 75, 76, 77, 95A, 97A, 102, 103, 109, 110, 125, 127, 129, 133, 134, 135.
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