



Manuals on methods of estimating population

MANUAL V

Methods of projecting the economically active population

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Manuals on methods of estimating population

MANUAL V

Methods of projecting the economically active population



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NOTE

In the tables ages are given in years.

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FOREWORD

Pursuant to recommendations of the Population Commission, the Population Division of the United Nations has prepared a series of manuals on methods of estimating population. Manual I (ST/SOA/Series.A/10) dealt with the methods of estimating total population for current dates. Manual II (ST/SOA/Series.A/23) described the procedures for appraising the quality of basic demographic data. Manual III (ST/SOA/Series.A/25) presented methods of calculating future population estimates by sex and age. Manual IV (ST/SOA/Series.A/42) was devoted to methods of estimating basic demographic measures from incomplete data. In addition, a study on estimating future school enrolment in developing countries (ST/SOA/Series.A/40) has been prepared jointly by the United Nations and UNESCO; and another technical study, on methods of analysing census data on economic activities of the population (ST/SOA/Series.A/43) has been prepared on the recommendation of the Population Commission.

The present manual describes methods of projecting the economically active population with regard to both the labour supply and demand. The study was a co-operative project of the United Nations and the International Labour Organisation. The contribution of the ILO was completed with the collaboration of Mr. Claude Vimont, Directeur de recherches à l'Institut national d'études démographiques, Paris (France).

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INTRODUCTION

The purpose of this manual is to give an account of those of the main methods of projecting labour supply and demand which are currently regarded as suitable for preparing quantified projections for periods of from 5 to 10 years. Shorter-term projections, including one-year projections, are not covered. In dealing with the determination of the trend of employment in future years, this manual describes not only projection techniques based on extrapolation of past trends, but also more complex methods which take into account all factors affecting labour supply and demand. The methods proposed have been classified according to their practical value and the advantages and disadvantages of each of them described; furthermore, special attention has been paid to the problems of developing countries, and an indication given in all cases as to whether the method discussed seems satisfactory for developed countries only or for developing countries only.

The manual is divided into three parts, with annexes containing examples which complement the text. Part One deals with labour supply, i.e., with projections of the economically active population and Part Two with labour demand, that is, the manpower requirements of the economy. Each of these parts is divided into three chapters: Chapter I gives the definition of economically active population used in the part concerned and outlines the problems of principle involved in making projections, Chapter II explains proposed projection methods in detail, and Chapter III is devoted to ancillary computations which will yield a more accurate projection of the trend of employment in future years, such as the preparation of working-life tables for the purpose of determining the labour supply or, for demand projections, the use of employment projections by occupation to prepare projections by level and type of training. Finally, in Part Three, supply and demand are collated.

Part One

METHODS OF PROJECTING LABOUR SUPPLY

Chapter I

GENERAL

Before describing methods of projecting labour supply, the concept of labour supply used here and the more common methods by which it is measured statistically must be fully understood. Various possible applications of labour supply projections and the principal methods for producing them are also discussed in this chapter.

A. DEFINITION OF THE CONCEPT OF LABOUR SUPPLY

Several different definitions of "economically active population" are in use: it may mean the total population seeking employment or the population already in employment, and certain categories of workers may or may not be included. The concept of labour supply is the equivalent of one of them, it means the "labour force", that is, the total number of persons who want employment, whether or not their wish is satisfied: if it is, these persons are employed, if not, they are seeking employment. This definition of the economically active population raises a number of difficult practical problems:

(a) When is a person deemed to have an occupation? The answer is very simple in the case of the employee or of the head of an enterprise working full-time throughout the year, but there are many other possible situations. For instance, some workers' occupation is only a part-time one: the case of the person working regularly throughout the year but only for a few hours a day can therefore be distinguished from that of the person who works intermittently, more in some seasons than in others; again, some persons work only occasionally, when they have the opportunity, possibly for a few days or a few months a year.

What minimum working time will qualify such persons as members of the economically active population in employment? The question is sometimes very difficult to answer. This is so, for instance, in the case of the family helper in developed countries, where the worker belongs to the family of the head of the enterprise in which he has his activity and receives no wages; usually the worker is the wife or one of the children of the head of an agricultural, handicraft or commercial enterprise. The classification of such persons creates difficult problems: some of them can be assimilated to full-time employees, from whom they differ only in legal status. In many cases, however, the help these workers provide is very limited and perhaps intermittent: the wife of a farmer for example may work

for most of the day on the farm, or provide a few hours, work a day, or work only on certain days of the year — harvest time. In the developing countries, the problem is even more difficult. Some of these countries are still in the nature of pre-industrial societies and have a population which is largely living in a subsistence economy. In such cases the distinction between workers and the economically inactive is a very fine—and often artificial—one, since every member of the family will be contributing to some extent to the production of commodities needed for the family group;¹

(b) Defining "unemployed population seeking employment" is equally complicated. The situation is clear only in the case of an unemployed worker who has lost his job and is actively looking for a new one. But there are many other situations: for example, there are women who, having given up their occupation entirely for some years or having never had a job, wish to enter working life; they are members of the labour force because they want to find work. Nevertheless, while some of these women are actively looking for work, others are passively waiting for a job which suits them to be offered. In the developing countries where employment opportunities are limited, especially in rural areas, those seeking work obviously cannot be said to be "actively" seeking it. In order correctly to enumerate the labour force in such cases persons who would accept employment if it were offered to them must be included;

(c) A special problem arises with regard to the armed forces: how should they be classified? Career soldiers are members of the economically active population in employment, but there may be some doubt about young men performing compulsory military service; in most cases these young men are accepted as members of the labour force.

B. MEANS OF ESTIMATING LABOUR SUPPLY

The population census or similar surveys are the principal means of estimating a country's labour supply at a given date. As part of the census or survey, questions are asked concerning one's occupation: Is the respondent in employment on the date of the survey? In what

¹ *Handbook of Population Census Methods, Vol. II: Economic Characteristics of the Population* (United Nations publication, Sales No.: 58.XVII.6/Vol. 2), chapter II.

sector of the economy is he working? What is his trade? If he is not employed, is he seeking employment? The essential advantage of this technique is that it is exhaustive in the case of a census, or, in the case of a sample survey, is at least representative of the total population.

There are, however, a number of errors or biases which may significantly affect the validity of the results. These errors fall into two categories: those affecting both estimates of total population and those of the economically active population, such as the omission of individuals or mis-statements of age, and those affecting only data on the economically active population, such as false statements of occupation or erroneous descriptions of the type of activity. Apart from errors, properly so called, there are many factors which give rise to uncertainty. As noted earlier, it is sometimes difficult to define occupation precisely in the case of part-time workers and, particularly, family members assisting the head of an enterprise or farm in his work. Every census uses a fairly rigid definition of an occupation, based on the number of hours of work required to qualify a person as economically active. Similarly, every census has its own fairly restrictive definition of persons seeking employment. The question which is asked, under the internationally recommended standards, is the following: "Was the person looking for work during the census reference period?" In some developing countries, however, the definition is much wider and the persons being enumerated are asked to state whether they want to work or would accept employment in certain specified circumstances.

There are other factors of unreliability, some of which may be difficult to detect. For example, the length of the reference period to which the census questions relate may sometimes have a significant influence. In some countries the period is one week, in others it may be one or more months or sometimes even a year. The longer the period is, the more numerous will be persons who have had an occasional or short-term occupation; the number of economically active persons will be higher than it would have been if the census had limited its coverage to, for example, persons who have worked during the previous week. Accordingly, a very rigorous analysis must be made of the definitions of economically active population used for censuses and of the manner in which each census is carried out before their results are interpreted. This critical approach is essential when the results of separate censuses are to be compared, either as between countries or in the same country over a period.

The quality of censuses has improved gradually, especially in the developing countries. Statistical data derived from censuses carried out in those countries before 1950 are of limited value and can be used only after detailed critical study and much adjustment. Hence it is usually impossible to establish statistical time series concerning trends in the economically active population. In any case, censuses constitute the essential basis for computing forecasts of labour supply, because they make it possible to calculate the sex-age specific activity rates of a country's population.

C. PURPOSE OF THE PROJECTION

The purpose of a labour supply projection is to estimate the size of the labour force in a future year. Such projections must be made by sex and by age group. As a rule the following age groups are used: 10-14, 15-19, 20-24, 25-34, 35-44, 45-54, 55-64, 65 and over. Sometimes age groups are combined, particularly for median ages, such as 25-44. It should be noted that the youngest age groups are absent in the case of countries where compulsory school attendance applies after the age of 10: the minimum age of accession to economically active life is that permitted by the legislation on education.

In theory, labour supply projections can be made for any period of time from one to twenty years. In practice, few short-term projections are made. The average projection period is approximately ten years, which means that in the calculations the factors which determine trends are long-term factors; short-term variations, generally associated with the effect of a changing economic situation on the size of the labour supply, are disregarded. Moreover, the projecting of labour supply varies in complexity, depending on the sex and the age group considered. Almost all adult males work; in most countries activity rates for males between twenty-five and fifty-four years reach a figure of between 93 and 98 per cent of the male population in this age group. These rates are assumed to be stable.² Activity rates do, however, vary appreciably for all females and for the youngest and oldest male groups. Table 1 illustrates how they differ according to sex and age. The bulk of the work of projecting labour supply is therefore concerned with population groups which are susceptible to variation in activity rates.

D. GENERAL ACCOUNT OF METHODS OF PROJECTING LABOUR SUPPLY

Two fundamental observations are required at the outset:

(a) Labour supply projections are, in fact, the product of two separate projections, a projection of total population by sex and age, and a projection of the activity rates for each group considered. The size of the labour force depends largely on the number of persons in the population who are of working age. Projections of total population by sex and by age therefore provide the basis for estimates of labour supply: anticipated changes in the size and composition of the total population have a direct influence on labour force projections, particularly long-term projections. The dependence of labour supply projections on other trends is illustrated by table 2, which

² However, significant variations, resulting from economic trends, have been noted in male activity rates for this age group in the former British colonies of the West Indies and in Puerto Rico, where, even if the magnitude of the variation is small, its influence on the size of the labour force is substantial, since this age group comprises a very high proportion of the population.

TABLE 1
Specific activity rates by sex and age for developed and developing countries: 1950, 1960 and 1970

Sex and age	Developed countries			Developing countries		
	1950	1960	1970	1950	1960	1970
MALES						
<i>All ages</i>	60.4	58.3	57.9	57.7	54.8	52.7
0-14	2.4	1.6	1.3	7.4	6.2	4.7
15-19	69.7	61.5	55.5	74.0	70.9	68.2
20-24	90.1	89.4	87.4	92.1	90.6	89.0
25-44	95.9	96.1	96.2	96.2	95.7	95.8
45-54	94.4	94.0	94.1	93.7	93.6	93.4
55-64	83.9	82.3	80.3	84.7	83.9	82.9
65 and over	42.3	34.2	30.4	53.4	51.8	47.6
FEMALES						
<i>All ages</i>	31.3	32.6	32.5	32.5	29.8	28.5
0-14	1.7	1.2	0.9	4.7	4.8	3.2
15-19	54.7	48.9	45.1	48.7	46.3	43.4
20-24	59.0	62.6	59.8	53.0	50.8	50.2
25-44	44.1	50.0	51.2	53.2	50.3	49.8
45-54	41.4	49.0	49.3	51.3	49.8	48.6
55-64	32.5	35.5	36.3	42.6	39.7	38.0
65 and over	13.6	13.0	12.4	21.9	22.0	19.8

SOURCE: J. N. Ypsilantis, "World and regional estimates and projections of labour force", *Sectoral Aspects of projections for the World Economy: First Interregional Seminar on Long-term Economic Projections: Volume III: Discussion Papers*, Elsinore, 14-27 August 1966 (United Nations publication, Sales No.: E.69.II.C.3).

shows the impact of population growth on the size and structure of the economically active population in countries with a high level of development and in developing countries in 1950-1960 and 1960-1970.

All of this indicates how dependent labour supply projections are on the quality of the projections of the total population of working age. If the projection is for a period of ten years, changes in fertility rates need not be taken into account since all persons who will accede to economically active life will have been born when the projection is made.³ Projections of mortality and migration trends, on the other hand, will play an important role. Nevertheless, when the projections are for a period of over ten years in developing countries and over fifteen years in developed countries, fertility must be taken into account;⁴

(b) Changes in the activity rates of the economically active population are brought about by a whole range

of economic and social factors, such as the number and type of jobs created for young people by economic development, school enrolment trends, the size of the old-age pension, and, for women in general, age at marriage, number of children, and educational level. To ascertain the degree to which all these factors influence the activity rates of the population is very difficult; it is generally assumed that activity rates evolve gradually under the pressure of the various factors and that long-term trends can be discerned. In developing countries, however, the gradual evolution may be interrupted as a result of rapid development of the economy. Moreover, as stated earlier, the establishment of a sufficiently long statistical time series for past trends in the economically active population is usually impossible.

For this reason, methods of projecting labour supply will vary according to the level of development of the country concerned, the quality of the statistics available and the importance of occupations as one of the factors determining trends in the economically active population. There are four principal methods, each of them based on one of the following assumptions:

(a) The trend in the activity rates of the economically active population for future years will be an extrapolation of the past trend;

(b) Current activity rates will be maintained in future years;

(c) Activity rates in future years will be the same as

³ Fertility projections are, however, a significant factor in estimating future female activity rates; fertility is, in fact, one of the factors most heavily influencing female occupational activity.

⁴ Different methods may be used to analyse the factors governing total population growth. On this point see: W. M. Illing, *Population, Family, Household and Labour Force Growth to 1980*, prepared for the Economic Council of Canada (Ottawa, Queen's printer, 1967); and R. A. Easterling, *Population, Labour Force and Long Swings in Economic Growth: the American Experience*, General Series 86 (New York, National Bureau of Economic Research, 1968).

those of other more advanced countries or the same as current rates in the more developed areas of the country concerned;

(d) Activity rates will depend on projected changes in such factors as the economy's manpower needs, school enrolment, the growth of the urban population, the development of the pension system, and nuptiality and fertility rates.

It must be remembered that projections made by these methods yield estimates of the size of the economically active population based on certain assumptions. If these assumptions prove to be unfounded the reliability of such conditional projections is affected. In fact, activity rates for future years are often projected by using a model combining two or more of the assumptions cited above (see annex I). The choice of method

depends on the reliability of the statistical sources available and on judgements regarding the prospects for economic and social development in the country concerned. These judgements may be concerned with the possibility of continued economic growth in future years, the capacity of the educational system to train young graduates and the absence of world wars.⁵ In countries where the non-availability of statistical data makes it impossible to determine past trends or even, in some cases, to ascertain the current situation, future activity rates are often calculated on the basis of examples drawn from other countries which in the

⁵ See, for example: United States of America, Bureau of Labour Statistics, *Population and Labor Force Projections for the United States, 1960 to 1975*, Bulletin No. 1242 (Washington (D.C.), 1959).

TABLE 2
Incidence of population growth and of changes in participation rates on the labour force
in developing and developed countries: 1950-1960, and 1960-1970

Indicators	Years	Developed countries		Developing countries	
		Males	Females	Males	Females
Population (thousands)	1950	414,143	458,109	833,547	809,269
	1960	478,121	515,917	1,009,465	993,774
	1970	539,249	570,306	1,253,146	1,233,338
Labour force (thousands)	1950	250,149	143,179	481,213	263,286
	1960	278,554	168,126	553,111	296,349
	1970	312,369	185,221	660,130	351,504
Participation rate (percentage)	1950	60.4	31.3	57.7	32.5
	1960	58.3	32.6	54.8	29.8
	1970	57.9	32.5	52.7	28.5
Growth of labour force:					
A: Total					
(a) Thousands	1950-1960	28,405	24,947	71,898	33,063
	1960-1970	33,815	17,095	107,019	55,155
(b) Percentage	1950-1960	11.3	17.4	14.9	12.6
	1960-1970	12.1	10.2	19.3	18.6
B: Due to population growth					
(a) Thousands	1950-1960	38,636	18,303	101,248	59,691
	1960-1970	35,828	17,794	133,613	71,186
(b) Percentage	1950-1960	15.4	12.8	21.0	22.7
	1960-1970	12.8	10.6	24.1	24.0
C: Due to changes in participation rate					
(a) Thousands	1950-1960	-10,231	6,644	-29,350	-26,628
	1960-1970	-2,013	-0,699	-26,594	-16,031
(b) Percentage	1950-1960	-4.1	4.6	-6.1	-10.1
	1960-1970	-0.7	-0.4	-4.8	-5.4
Crude increase in the labour force resulting from population growth					
(B/A)	1950-1960	136.0	73.4	140.8	180.5
	1960-1970	106.0	104.1	124.9	129.1

SOURCE: J. N. Ypellantis, "World and regional estimates and projections of labour force", *Sectoral Aspects of Projections for the World Economy; First Interregional Seminar on Long-term Economic Projections; Volume III: Discussion Papers*, Elsinore, 14-27 August 1966 (United Nations publication, Sales No.: E.69.II.C.3).

past followed the same course as the country concerned.⁶ This method is often used in the case of developing countries and whenever it seems unlikely that past trends in a country will continue in the future because of changes anticipated in the economic, social and cultural factors which obtained in the past.

⁶ For example, in the case of Puerto Rico, projections of the economically active population were based on the assumption that the specific activity rates of the economically active population of the United States in 1950, by age, sex and level of education, would be attained in 1975. In this connexion, see: *Puerto Rico, Bureau of Employment Security, Puerto Rico's Manpower Needs and Supply* (Puerto Rico, 1957), p. 61. In Argentina, the first assumption used is that female activity rates in 1980 would be the same as those recorded in the United States in 1950. A second assumption is that the economic and social conditions existing in the United States in 1950 could not be achieved in Argentina

The main purpose of this Manual is to study these different methods of projecting labour supply by sex and age, over a period of about ten years; the problems of projecting the total population will not be considered here.⁷ Only methods of calculating the age-sex-specific activity rates will be studied. Different methods will be proposed, depending on the level of economic development of the country and the availability of statistical data.

until 1980. In the latter case, the activity rates of the youngest age groups would remain relatively high and show only a gradual decline. (See: Organization for European Co-operation and Development, *Education, Human Resources and Development in Argentina* (Paris, 1967), p. 330.)

⁷ On this subject, see *Methods for Population Projections by Sex and Age*, 1957 (United Nations publication, Sales No.: 56.XIII.3).

Chapter II

METHODS OF PROJECTING ACTIVITY RATES

The methods are of two main types. In the first the future activity rates of the population are projected by extrapolating the past trends observed in these rates, either in the country under study or in countries whose economic development is similar. In the second certain techniques are employed to correlate the activity rates observed at a given date in various areas of a country or in countries at different levels of development with certain measures which typify economic development, such as the anticipated rate of industrialization. Furthermore, recent advances in the techniques for demographic calculations have enabled matrix methods to be used to produce a model projection of the economically active population in which the number of factors that can be allowed for in estimating the future activity rates of the population is substantially increased.

The calculations made by both these methods have their limitations. Neither the extrapolation nor the correlation method is capable of giving consistently satisfactory results, particularly in the projection of the activity rates of the youngest and oldest age groups.

A. EXTRAPOLATION METHODS

The first part of this section describes a number of extrapolation techniques and their application to the statistics of the economically active population of Japan. Thereafter the extrapolation method developed by the International Labour Office is described.

1. Various extrapolation methods; application to Japan (a) Direct extrapolation by age group and by sex

Future economic activity rates may be computed by linear extrapolation of observed trends. This method is the simplest and the most frequently employed, but it is unsatisfactory for a number of reasons, the most important of which is that it can yield impossible results. For instance, in the case of age groups whose activity rates are very high, the method may yield percentages above the maximum of 100 (for one example, see annex III). These drawbacks are not overcome by resort to geometric projection if the trend being projected is a rising one. A better method is to weight the changes in the activity rate with a coefficient that will have the effect of ruling out negative percentages or percentages above 100.¹

¹ John D. Durand, *The Labour Force in the United States 1890-1960* (New York, Social Science Research Council, 1948), pp. 238 and 239. The weight adopted by the author has the

This correction coefficient is obtained by dividing the product of the rates of activity and inactivity at the beginning and end of the past period. The extrapolation formula is as follows:

$$a_{t_1}^x = a_t^x \frac{100 \pm \Delta_{t,t_1}^x}{100}$$

In this equation, a^x represents the activity rate of persons of age x ; Δ_{t,t_1}^x the recorded percentage increase — or decrease — in the activity rate of persons of age x in the base period, which is deemed also to apply to the projection period; t the beginning of the projection period or the end of the base period; and t_1 the end of the projection period. It should be noted that the projection period and the base period are here assumed to be of the same duration. If this is not the case, the mean rate of change for a period of the same duration must be computed. When the adjusted coefficient is applied, the percentage increase — or decrease — may be computed in two ways, using one of the following equations:²

$$\text{Equation (a): } \Delta_{t,t_1}^x = \left(\frac{a_{t_1}^x}{a_t^x} \right) \left(\frac{a_t^x \times u_t^x}{a_{t_1}^x \times u_{t_1}^x} \right)$$

$$\text{Equation (b): } \Delta_{t,t_1}^x = 1 + \left(\frac{a_{t_1}^x}{a_t^x} - 1 \right) \left(\frac{a_t^x \times u_t^x}{a_{t_1}^x \times u_{t_1}^x} \right),$$

in which u^x represents the inactivity rate of persons of age x and t_0 the beginning of the base period. In (a) the ratio of the total increase — or decrease — is multiplied by the adjusted coefficient, whereas in (b) only the increase itself — or the decrease — is thus modified. Examples of projections in which these extrapolations were used are given in annexes I and II and brief illustrations of the computations themselves in tables 3 and 4.

(b) Indirect extrapolation, by age group and by sex

Sometimes, instead of extrapolating activity rates, it may be advantageous to use inactivity rates. This method is particularly recommended when activity rates are assumed to be increasing gradually,³ as in the

property of retarding the rate of increase in the activity rates when these are very high and of accelerating their increase when they are low.

² In these equations $t_0 < t < t_1$.

³ G. Bancroft, *The American Labor Force: Its Growth and Changing Composition*, (New York, Wiley, 1958), p. 176.

TABLE 3

Japan: activity rates of the male economically active population for 1965, estimated by direct extrapolation of 1955 and 1960 data for each age group, with the correction coefficient (equation (a))

(x)	a_{1955}^x	a_{1960}^x	$\frac{a_{1960}^x}{a_{1955}^x}$	$a_{1960}^x \times u_{1960}^x$	$a_{1965}^x \times u_{1965}^x$	$\frac{a_{1960}^x \times u_{1960}^x}{a_{1955}^x \times u_{1955}^x}$	$\left(\frac{a_{1960}^x}{a_{1955}^x}\right) \left(\frac{a_{1960}^x \times u_{1960}^x}{a_{1955}^x \times u_{1955}^x}\right)$	a_{1965}^x
(1)	(2)	(3)	(4)	(5)	(6)	(7) = (3) : (6)	(8) = (4) × (7)	(9) = (3) × [100 ± (8)] : 100
15-19	52.1	50.7×0.9731		$50.7 \times 49.3 = 2,449.51$	$52.1 \times 47.9 = 2,495.59$	0.98153	0.9551	51.2
20-24	85.2	86.8×1.0188		$86.8 \times 13.2 = 1,145.76$	$85.2 \times 14.8 = 1,260.96$	0.90864	0.9257	87.6
25-29	93.7	96.0×1.0245		$96.0 \times 4.0 = 384.0$	$93.7 \times 6.3 = 590.31$	0.65050	0.6664	96.6
30-34	95.1	97.1×1.0210		$97.1 \times 2.9 = 281.59$	$95.1 \times 4.9 = 465.99$	0.60428	0.6170	97.7
35-39	95.8	97.2×1.0146		$97.2 \times 2.8 = 272.16$	$95.8 \times 4.2 = 402.36$	0.67640	0.6863	97.9
40-44	95.9	97.1×1.0125		$97.1 \times 2.9 = 281.59$	$95.9 \times 4.1 = 393.79$	0.71617	0.7251	97.8
45-49	95.5	96.7×1.0126		$96.7 \times 3.3 = 319.11$	$95.5 \times 4.5 = 429.75$	0.74254	0.7519	97.4
50-54	93.8	95.1×1.0139		$95.1 \times 4.9 = 465.99$	$93.8 \times 6.2 = 581.56$	0.80127	0.8124	95.9
55-59	88.7	89.5×1.0090		$89.5 \times 10.5 = 939.75$	$88.7 \times 11.3 = 1,002.31$	0.93755	0.9460	90.3
60-64	81.5	81.9×1.0049		$81.9 \times 18.1 = 1,482.39$	$81.5 \times 18.5 = 1,507.75$	0.98318	0.9880	82.7
65 +	55.7	54.5×0.9785		$54.5 \times 45.5 = 2,479.75$	$55.7 \times 44.3 = 2,467.51$	1.00496	0.9834	54.0

TABLE 4

Japan: activity rates of the male economically active population for 1965, estimated by direct extrapolation of 1955 and 1960 data for each age group, with the correction coefficient (equation (b))

(x)	a_{1955}^x	a_{1960}^x	$\frac{a_{1960}^x}{a_{1955}^x}$	$\frac{a_{1960}^x \times u_{1960}^x}{a_{1955}^x \times u_{1955}^x}$	$\frac{a_{1960}^x}{a_{1955}^x} - 1$	$\left(\frac{a_{1960}^x}{a_{1955}^x} - 1\right) \left(\frac{a_{1960}^x \times u_{1960}^x}{a_{1955}^x \times u_{1955}^x}\right)$	$1 + \left(\frac{a_{1960}^x}{a_{1955}^x} - 1\right) \left(\frac{a_{1960}^x \times u_{1960}^x}{a_{1955}^x \times u_{1955}^x}\right)$	a_{1965}^x
(1)	(2)	(3)	(4)	(5)	(6) = (4) - 1	(7) = (6) × (5)	(8) = 1 + (7)	(9) = (3) × (8)
15-19	52.1	50.7	0.9731	0.98153	-0.0269	-0.0264	0.9736	49.3
20-24	85.2	86.8	1.0188	0.90864	0.0188	0.0171	1.0171	88.3
25-29	93.7	96.0	1.0245	0.65050	0.0245	0.0159	1.0159	97.5
30-34	95.1	97.1	1.0210	0.60428	0.0210	0.0127	1.0127	98.3
35-39	95.8	97.2	1.0146	0.67640	0.0146	0.0099	1.0099	98.2
40-44	95.9	97.1	1.0125	0.71617	0.0125	0.0090	1.0090	98.0
45-49	95.5	96.7	1.0126	0.74254	0.0126	0.0094	1.0094	97.6
50-54	93.8	95.1	1.0139	0.80127	0.0139	0.0111	1.0111	96.2
55-59	88.7	89.5	1.0090	0.93755	0.0090	0.0084	1.0084	90.3
60-64	81.5	81.9	1.0049	0.98318	0.0049	0.0048	1.0048	82.3
65 +	55.7	54.5	0.9785	1.00496	-0.0215	-0.0216	0.9784	53.3

case of the female labour force. The following formula may be used:

$a_t^x = 100 - (u_t^x \cdot \alpha)$, in which $\alpha = u_t^x / u_{t_0}^x$, or the ratio of the inactivity rates of persons of age x in the periods t and t_0 . Here again, the correction coefficient may be used in the same way as in the methods described earlier. An illustration is given in table 5. Examples of future activity rates extrapolated by this method, but without using the correction coefficient, are given in annex V; the correction coefficient is applied in the examples in annex IV.

(c) Extrapolation by cohort

This method works on the assumption that the pattern of change in the activity rates of a given age group — or cohort — during the projection period will be the same as that observed for a cohort in the same age group in an earlier period. This method is of

particular value for categories of the economically active population whose activity rates show marked variations over a period of time. It is thus very useful for projecting the activity rates of the female population. The formula for extrapolation by cohort is:

$$a_{t_1}^x = a_t^x \times \frac{a_t^{x_0}}{a_{t_0}^{x_0}}$$

in which x_0 represents the age group preceding age group x , and $a_t^x / a_{t_0}^{x_0}$ the ratio of the activity rates by cohort. In order to determine the activity rates of women who will be in the 25-29 age group in 1970, the pattern of change observed in the activity rates for 1960-1965 of women who were in the 20-24 age group in 1960 is applied to the activity rates of women in the 20-24 age group in 1965 (see table 6).

TABLE 5

Japan: activity rates of the male economically active population for 1965, estimated by indirect extrapolation of 1955 and 1960 data for each age group, with and without the correction coefficient

(x)	u_{1955}^x	u_{1960}^x	$\gamma = \frac{u_{1960}^x}{u_{1955}^x}$	$u_{1960}^x \times \gamma$	a_{1965}^x	$\frac{a_{1960}^x \times u_{1960}^x}{a_{1955}^x \times u_{1955}^x}$	$(u_{1960}^x \times \gamma) \left(\frac{a_{1960}^x \times u_{1960}^x}{a_{1955}^x \times u_{1955}^x} \right)$	a_{1965}^b
(1)	(2)	(3)	(4) = (3) : (2)	(5) = (4) × (3)	(6) = 100 - (5)	(7)	(8) = (5) × (7)	(9) = 100 - (8)
15-19 . . .	47.9	49.3	1.0292	50.7	49.3	0.98153	49.8	50.2
20-24 . . .	14.8	13.2	0.8918	11.8	88.2	0.90864	10.7	89.3
25-29 . . .	6.3	4.0	0.6349	2.5	97.5	0.65050	1.6	98.4
30-34 . . .	4.9	2.9	0.5918	1.7	98.3	0.60428	1.0	99.0
35-39 . . .	4.2	2.8	0.6666	1.9	98.1	0.67640	1.3	98.7
40-44 . . .	4.1	2.9	0.7073	2.1	97.9	0.71617	1.5	98.5
45-49 . . .	4.5	3.3	0.7333	2.4	97.6	0.74254	1.8	98.2
50-54 . . .	6.2	4.9	0.7903	3.9	96.1	0.80127	3.1	96.9
55-59 . . .	11.2	10.5	0.9292	9.8	90.2	0.93755	9.2	90.8
60-64 . . .	18.5	18.1	0.9783	17.7	82.3	0.98318	17.4	82.6
65 years and over . . .	44.3	45.5	1.0270	46.7	53.3	1.00496	46.9	53.1

(x)	$\gamma - 1$	$(\gamma - 1) \left(\frac{a_{1960}^x \times u_{1960}^x}{a_{1955}^x \times u_{1955}^x} \right)$	$(\gamma - 1) \left(\frac{a_{1960}^x \times u_{1960}^x}{a_{1955}^x \times u_{1955}^x} \right) + 1$	$u_{1960}^x \left[(\gamma - 1) \left(\frac{a_{1960}^x \times u_{1960}^x}{a_{1955}^x \times u_{1955}^x} \right) + 1 \right]$	a_{1965}^c
(1)	(10) = (4) - 1	(11) = (10) × (7)	(12) = (11) + 1	(13) = (3) × (12)	(14) = 100 - (13)
15-19 . . .	0.0292	0.0287	1.0287	50.7	49.3
20-24 . . .	-0.1081	-0.0982	0.9018	11.9	88.1
25-29 . . .	-0.3651	-0.2375	0.7625	3.1	96.9
30-34 . . .	-0.4082	-0.2467	0.7533	2.2	97.8
35-39 . . .	-0.3333	-0.2254	0.7746	2.2	97.8
40-44 . . .	-0.2927	-0.2096	0.7904	2.3	97.7
45-49 . . .	-0.2667	-0.1980	0.8020	2.6	97.4
50-54 . . .	-0.2097	-0.1680	0.8320	4.1	95.9
55-59 . . .	-0.0708	-0.0664	0.9336	9.8	90.2
60-64 . . .	-0.0216	-0.0212	0.9788	17.7	82.3
65 + . . .	0.0270	0.0272	1.0272	46.7	53.3

* Correction coefficient not applied.

^b Correction coefficient (equation (a)) applied.

^c Correction coefficient (equation (b)) applied.

TABLE 6

Japan: estimated activity rates of the female labour force for 1965, based on extrapolation by cohort of 1955 and 1960 data for each age group with and without the correction coefficient ^a

(x)	$\frac{a_{1960}^x}{a_{1955}^x}$	$\frac{x}{a_{1960}}$	a_{1955}^x	a_{1960}^x	a_{1965}^x	$\frac{a_{1960}^x}{a_{1955}^x} - 1$	$\left(\frac{a_{1960}^x}{a_{1955}^x} - 1\right) \left(\frac{a_{1960}^x \times u_{1960}^x}{a_{1955}^x \times u_{1955}^x}\right)$	$1 + \left[\left(\frac{a_{1960}^x}{a_{1955}^x} - 1\right) \left(\frac{a_{1960}^x \times u_{1960}^x}{a_{1955}^x \times u_{1955}^x}\right)\right]$	$\frac{x}{a_{1965}}$
(1)	(2)	(3)	(4) = (3) × (2)	(5)	(6)	(7)	(8)	(9) = (8) + 1	(10) = (3) × (9)
15-19	—	—	—	—	—	—	—	—	—
20-24	1.416	48.9	69.2	62.9	59.9	0.416	0.404	1.404	68.7
25-29	0.752	68.4	51.4	33.4	57.8	-0.248	-0.248	0.752	51.4
30-34	0.984	50.1	49.3	29.8	49.3	-0.016	-0.016	0.984	49.3
35-39	1.108	50.7	56.2	38.0	55.8	0.108	0.107	1.107	56.1
40-44	1.088	54.4	59.2	42.4	58.2	0.088	0.087	1.087	59.1
45-49	1.022	57.0	58.3	43.3	58.0	0.022	0.022	1.022	58.3
50-54	0.958	56.5	54.1	43.3	54.4	-0.042	-0.042	0.958	54.1
55-59	0.907	51.9	47.1	44.2	46.8	-0.093	-0.093	0.907	47.1
60-64	0.852	45.8	39.0	35.2	37.4	-0.148	-0.148	0.852	39.0
65 years and over . . .	0.547	39.1	21.4	21.5	15.3	-0.453	-0.458	0.542	21.2

^a Computations:

(4) simple extrapolation by cohort.

(5) extrapolation by cohort multiplied by the correction coefficient $\left(\frac{a_{1960}^x \times u_{1960}^x}{a_{1955}^x \times u_{1955}^x}\right)$

(6) extrapolation by cohort multiplied by the cohort correction coefficient $\left(\frac{a_{1960}^x \times u_{1960}^x}{a_{1955}^x \times u_{1955}^x}\right)$

(10) extrapolation by cohort with the correction coefficient applied to the increase — or decrease — in activity rates.

(d) *Comparison of the results obtained by the various extrapolation methods*

The results of the computations vary according to the method used. Table 7 clearly illustrates that this is so, both in the case of projections made for 1965 and in some which have been made for 1985. The differences are slight as between the techniques of direct and indirect extrapolation; the difference between projections obtained by these techniques and those derived by the method of extrapolation by cohort is wider.

The merits of the correction coefficient ($a_t^x \times u_t^x / a_t^y \times u_t^y$) are especially evident in long-term projections of activity rates for specified age groups. Annex III shows how, unless the correction coefficient is used, the direct extrapolation method yields absurd results, such as activity rates of 109 per cent for the 25-29 age group in Japan for 1985. When the projection period is short, however, the likelihood of obtaining a negative percentage or a percentage above 100 is probably negligible;

in such cases, it is not essential to use the correction coefficient when computing future activity rates. The illustrative projections for Japan for the period 1960-1965 can be compared with the real pattern of labour supply in the same period. The discrepancies are very slight in the case of adult male age groups whose activity rates are relatively stable; they are considerably greater for the female population as a whole and for the youngest and oldest male groups. Such discrepancies may be explained by the fact that in projecting activity rates for these groups, the necessary adjustments have to be made for probable trends in such endogenous variables as the economic structure, school enrolment rates and the social security system; the mechanical approach imposed by the use of such rigid mathematical formulae as those described above makes no allowance for such adjustments. This problem, and the solutions it calls for, will be discussed in section D of this chapter.

Finally, it is interesting to compare the projections developed for Japan for 1985 by the different methods

TABLE 7
Japan: projections of sex- and age-specific activity rates of the economically active population, 1965 and 1985; comparison of extrapolation methods

	Activity rates ^a				Deviation from actual data				Activity rates ^a				Deviation from official projections			
	a	b	c	d	b	c	d	A	b	c	d	b	c	d		
	1965								1985							
<i>Males</i>																
15-19	38.6	49.3	49.3	—	10.7	10.7	—	40.0	43.7	43.7	—	37.7	37.7	—		
20-24	87.1	88.3	81.1	81.4	1.2	1.0	-5.7	85.5	93.3	91.6	—	7.8	6.1	—		
25-29	97.9	97.5	96.9	94.0	-0.7	-1.0	-3.9	95.9	99.7	98.3	—	3.8	2.4	—		
30-34	98.6	98.3	97.8	98.1	-0.3	-0.8	-0.5	96.8	99.7	98.9	—	2.9	2.1	—		
35-39	98.4	98.2	97.8	98.6	-0.2	-0.6	0.2	97.2	99.8	98.9	—	2.6	1.7	—		
40-44	98.3	98.0	97.7	98.2	-0.3	-0.6	-0.1	97.2	99.5	98.8	97.8	2.3	1.6	0.6		
45-49	98.0	97.6	97.4	97.7	-0.4	-0.6	-0.3	96.8	99.5	98.5	96.4	2.7	1.7	-0.4		
50-54	97.2	96.2	95.9	96.4	-1.0	-1.3	-0.8	95.2	98.7	97.4	99.3	3.5	2.2	4.1		
55-59	93.8	90.3	90.2	91.0	-3.5	-3.6	-2.8	88.3	93.0	92.2	97.7	4.7	3.9	9.4		
60-64	85.3	82.3	82.3	82.7	-3.0	-3.0	-2.6	78.2	83.9	84.1	91.4	5.7	5.9	13.2		
65 years and over . . .	55.1	53.3	53.3	54.6	-1.8	-1.8	-0.5	39.2	48.5	48.4	59.9	9.3	9.2	20.7		
<i>Females</i>																
15-19	37.6	49.5	49.5	—	11.9	11.9	—	40.0	51.9	51.9	—	11.9	11.9	—		
20-24	69.7	70.2	70.1	68.7	0.5	0.4	-1.0	65.0	77.4	75.9	—	12.4	10.9	—		
25-29	46.4	48.7	48.7	51.4	2.3	2.3	5.0	38.4	43.3	54.3	—	4.9	15.9	—		
30-34	48.0	52.3	52.2	49.3	4.3	4.2	1.3	32.8	58.9	59.2	—	26.1	26.4	—		
35-39	58.3	56.5	56.3	56.1	-1.8	-2.0	-2.2	36.3	65.6	62.9	—	29.3	26.6	—		
40-44	62.1	58.7	58.6	59.1	-2.4	-3.5	-3.0	39.0	65.5	64.0	61.0	26.5	25.0	22.0		
45-49	62.6	58.9	58.7	58.3	-3.7	-3.9	-4.3	37.2	69.1	66.5	62.3	31.9	29.3	25.1		
50-54	57.3	53.3	53.3	54.1	-4.0	-4.0	-3.2	32.1	59.1	58.7	58.1	27.0	26.6	26.0		
55-59	50.1	45.7	45.7	47.1	-4.4	-4.4	-3.0	25.8	45.3	45.3	54.4	19.5	19.5	28.6		
60-64	39.3	39.1	39.1	39.0	-0.2	-0.2	-0.3	16.8	39.1	39.1	44.6	22.3	22.3	27.8		
65 years and over . . .	17.6	21.7	21.7	21.2	4.1	4.1	3.6	5.3	22.9	22.9	22.8	17.6	17.6	17.5		

^a Explanatory note:

a: Official estimates for 1965; see Japan, Institute of Population Problems, *Estimates of Future Labour Force Population in Japan for 1 October from 1965 to 1985, Estimated in December 1966* (Tokyo, 1967).

A: Official projection for 1985, variant C (for an explanation of the method used, see Section B of this chapter).

b: Direct extrapolation for each age group, applying the correction coefficient to the increase — or decrease — in activity rates.

c: Indirect extrapolation for each age-group, applying the correction coefficient to the increase — or decrease — in activity rates.

d: Extrapolation by cohort, applying the correction coefficient to the increase — or decrease — in activity rates.

When the correction coefficient is not applied, impossible rates are obtained, even for 1970; see simple direct extrapolation (annex III) and extrapolation by cohort (annex VII).

described here with the country's own official estimates. The method used in making these estimates is described below in the section B.1 of this chapter, which outlines methods involving correlation techniques. In it, correlations are computed and the results corrected to allow for the probable incidence of such endogenous variables as the prospects for female employment, school enrolment rates and pension systems. The differences in the case of female activity rates are substantial but are less marked in the case of the male rates, where, even if they are significant in the youngest and oldest age groups, they are slight for the adult age groups and probably arise from the fact that the extrapolation techniques used for the long-term projections yield activity rates of very nearly 100 per cent in 1985. This figure is, of course, a practical impossibility since there will always be a small percentage of adult males who are unable to work.

These comparisons show that the results obtained by different projection techniques must be analysed carefully, particularly when they fail to take account of the potential effect of new economic or social factors in future years (see section D of this chapter).

(e) *An additional method: ratios of the activity rates of contiguous age groups*

Another method of extrapolation which has been used to estimate activity rates is to calculate the ratios of the activity rates of contiguous age groups. This extrapolation is based on the concept that there is a relationship between the activity rates of different age groups which can be expressed in the form of a ratio. On the curve of the sex-specific activity rates the age group whose activity rate is relatively the most stable is selected: for males this is generally an age group near the midpoint of the curve, for females, the age group selected as central will depend on the structure of economic activity peculiar to the country in question. Starting with this age group, the ratios of the activity rates of pairs of contiguous age groups are calculated. For example, if the 40-44 male age group is the one selected, the ratio for the 35-39 age group will be $(35-39)/(40-44)$; for the 45-49 age groups $(45-49)/(40-44)$, for the age 50-54 age group $(50-54)/(45-49)$, and so on. The activity rates projection for Japan for 1960-1985 provides an example (see table 8 and annex VIII).

The first step is to calculate the ratios of contiguous (adjacent) age groups and to determine whether they have increased or decreased in an earlier period (1955-1960). An assumption is then made as to future changes in the activity rate of the age group selected as the central group. In the case of Japan, the age groups selected were the 40-44 group for males and the 20-24 group for females. For these age groups activity rates derived by indirect extrapolation were used: the rates for 1985 were 98.8 for males and 75.2 for females (see annex VIII). Next, the contiguous ratios for each age group for the target year are computed. These ratios are generally abstracted from models which applied in the earlier period and, when possible, are also adjusted to embody assumptions concerning socio-economic and demographic variables which might cause

changes in the proportions of the economically active population. For the sake of simplicity, it is assumed in table 8 (column 8) that the relative increase — or decrease — in the ratios of contiguous age groups for the projection period 1960-1985 would be the same as that observed during 1955-1960.⁴ The ratio for each age group at the beginning of the projection period is then multiplied by the total observed increase — or decrease — in order to project the ratios of the activity rates of contiguous age groups to the target year of 1985. These ratios and the activity rates of the central age group form the basis for the calculation of activity rates for specific age groups for the target year. A linear extrapolation is used to determine activity rates at times between the initial year and the final year of the projection period. This method has the same drawbacks as the extrapolation methods described earlier.

2. *Methods of projection by extrapolation developed by the International Labour Office*

The ILO has prepared sex-age-specific activity rate projections for the period 1960-1980 for twenty-three regions of the world⁵ and some of their component countries. These projections were calculated on the basis of trends reported between 1950 and 1960 for the following age groups: 0-14, 15-19, 20-24, 25-44, 45-54, 55-64, and 65 and over. Separate projections were made for the 1960-1970 and 1970-1980 periods. These projections can be used by countries wishing to draw up activity rate forecasts for those years.⁶

An account follows of the methods used by the ILO to calculate future regional activity rates and the way in which these regional forecasts can be used to compute future activity rates for a given country.

(a) *The ILO method for regional projections*

Three estimation procedures were applied concurrently to determine activity rates for a given region.

⁴ Various assumptions can be used, depending on the specific situation. For example, one reasonable assumption would take the form of multiplying the increase — or decrease — of the ratio for each age group by the number of times by which the projection period is greater than the time interval of the base period (see Economic Commission for Latin America, *Población y mano de obra en Panamá 1950-1985*, (preliminary version) (E/CN.12/789, 1 August 1966). The projection contained in annex VIII, in which the projection period 1960-1985 is divided into two parts — 1960-1975 and 1975-1985 — provides another example. Changes for the period 1960-1975 are assumed to be the same as those in 1955-1960, and changes for the period 1975-1985 the same as those in 1960-1975.

⁵ The twenty-three regions are identical with the United Nations classification system. See United Nations *Demographic Yearbook 1967* (United Nations publication, Sales No.: 68.XIII.1), p. 18. The twenty-fourth region — Polynesia and Micronesia — has been excluded for lack of proper data.

⁶ For a more detailed description of these methods see: Ypsilantis, op. cit.; also "Methods of Estimation and Projection of Labour Force Sex-Age-Specific Activity Rates", document prepared by the International Labour Office for an inter-agency meeting of experts on demographic projections (New York, POP/SC/WP/6, December 1968); and J. N. Ypsilantis, "Projections of Manpower Supply", discussion paper submitted to a meeting of the International Statistical Institute on manpower projections, held at London in September 1969.

TABLE 8

Japan: projections of sex- and age-specific activity rates of the economically active population (1960-1985) by the method of activity rate ratios of contiguous age groups ^a

Sex and age	Activity rates			Ratios of contiguous age groups			Increase (or decrease) in the ratios		Increase (decrease)		Projected activity rates				
	Observed		Pro- jected												
	1955	1960	1985	1955	1960	1985	1960/1955 = 1985/1960	1960-1985	5 years		1965	1970	1975	1980	1985
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8) = (6) : (5)	(9) = (4) - (3)	(10) = (9) : (5)		(11)	(12)	(13)	(14)	(15) = (4)
Males															
15-19	52.1	50.7	49.5	0.61150	0.58410	0.55793	0.955192	-1.2	-0.24		50.5	50.2	50.0	49.7	49.5
20-24	85.2	86.8	88.8	0.90928	0.90416	0.89907	0.994369	2.0	0.40		87.2	87.6	88.0	88.4	88.8
25-29	93.7	96.0	98.8	0.98527	0.98867	0.99208	1.003450	2.8	0.56		96.6	97.1	97.7	98.3	98.8
30-34	95.1	97.1	99.6	0.99269	0.99897	1.00529	1.006326	2.5	0.50		97.6	98.1	98.6	99.1	99.6
35-39	95.8	97.2	99.1	0.99895	1.00102	1.00309	1.002072	1.9	0.38		97.6	98.0	98.3	98.7	99.1
40-44	95.9	97.1	98.8	—	—	—	—	1.7	0.34		97.4	97.8	98.1	98.7	98.8
45-49	95.5	96.7	98.4	0.99582	0.99588	0.99594	1.000060	1.7	0.34		97.0	97.4	97.7	98.1	98.4
50-54	93.8	95.1	96.9	0.98219	0.98345	0.98471	1.001282	1.8	0.36		95.5	95.8	96.2	96.5	96.9
55-59	88.7	89.5	90.8	0.94562	0.94111	0.93662	0.995230	1.3	0.26		89.8	90.0	90.3	90.5	90.8
60-64	81.5	81.9	82.8	0.91882	0.91508	0.91135	0.995929	0.9	0.18		82.1	82.3	82.4	82.6	82.8
65 and over	55.7	54.5	53.6	0.68343	0.66544	0.64792	0.973676	-1.1	-0.22		54.3	54.1	54.0	53.8	53.6
Females															
15-19	48.3	48.9	53.5	0.72522	0.71491	0.70475	0.985783	4.6	0.92		49.8	50.7	51.7	52.6	53.5
20-24	66.6	68.4	75.9	—	—	—	—	7.5	1.50		69.9	71.4	72.9	74.4	75.9
25-29	51.5	50.1	52.7	0.77327	0.73245	0.69378	0.947211	2.6	0.52		50.6	51.1	51.7	52.2	52.7
30-34	49.1	50.7	56.6	0.95339	1.01197	1.07415	1.061443	5.9	1.18		51.9	53.1	54.2	55.4	56.6
35-39	52.4	54.4	61.1	1.06720	1.07297	1.07877	1.005406	6.7	1.36		55.7	57.1	58.4	59.8	61.1
40-44	55.3	57.0	63.6	1.05534	1.04779	1.04029	0.992845	6.6	1.32		58.3	59.6	61.0	62.3	63.6
45-49	54.2	56.5	63.8	0.98010	0.99122	1.00247	1.011345	7.3	1.46		58.0	59.4	60.9	62.3	63.8
50-54	50.5	51.9	57.8	0.93173	0.91858	0.90562	0.985886	5.9	1.18		53.1	54.3	55.4	56.6	57.8
55-59	45.9	45.8	49.5	0.90891	0.88246	0.85678	0.970899	3.7	0.74		46.5	47.3	48.0	48.8	49.5
60-64	39.1	39.1	42.4	0.85185	0.85371	0.85557	1.002183	3.3	0.66		39.8	40.4	41.1	41.7	42.4
65 and over	21.1	61.4	23.5	0.53964	0.54731	0.55509	1.014213	2.1	0.42		21.8	22.2	22.7	23.1	23.5

^a Computations:

- (4) = (4) 40-44 age group × (7) 35-39 age group
 (4) 35-39 age group - (7) 30-34 age group
 (5) = (2) 35-39 age group : (2) 40-44 age group
 (2) 30-34 age group : (2) 35-39 age group
 etc.

- (6) = (3) 35-39 age group : (3) 40-44 age group
 (3) 30-34 age group : (3) 35-39 age group
 (7) = (6) × (8)
 (11) = (3) + (10)
 (12) = (11) + (10)
 (13) = (12) + (10)
 (14) = (13) + (10)

(i) The first estimate is made by multiplying the activity rates of the region in 1960 by the weighted average of the changes in the activity rates of the component countries of the region in 1950-1960. The application of this procedure to Temperate South America is illustrated in table 9.

The sex-age-specific activity rates for the region in 1970 are projected on the basis of the trend thus obtained. An example of the calculation is given in table 10 (columns 3 and 4). This method assumes the continuance in the future of the trends observed in 1950-1960 in all the component countries of the region;

(ii) The second estimate utilizes the patterns of change in activity rates observed in 1950-1960 in other regions of the world which had reached, in 1960, almost identical activity rates and similar levels of economic development. The changes in the average activity rates of these

other regions are calculated and then used to project the activity rates of the region concerned. This second approach is illustrated in table 11, which sets forth the computed average change in activity rates in Japan, Southern Europe and Southern Africa in 1950-1960.⁷ This pattern is then applied to the average observed activity rates for 1960 for Temperate South America. This procedure yields estimated activity rates for that region in 1970 (for results, see table 10, columns 5, 6 and 7);

⁷ Decennial patterns of change in the activity rates of the twenty-three regions of the world for 1950-1960, 1960-1970 and 1970-1980 can be calculated from regional tables. See J. N. Ypsilantis, "World and Regional Estimates and Projections of Labour Force", *Sectoral Aspects of Projections for the World Economy; First Interregional Seminar on Long-term Economic Projections; Volume III: Discussion Papers*, Elsinore, 14-27 August 1966 (United Nations publication, Sales No.: E.69.II.C.3).

TABLE 9
Temperate South America: estimates of regional patterns of change in male and female age-specific activity rates according to the weighted patterns observed during 1950-1960

Sex and age groups	Total	Argentina	Chile	Uruguay	Paraguay
Males					
<i>Proportion of labour force in each age group</i>					
0-14	100.00	54.32	22.99	8.87	13.82
15-19	100.00	63.51	22.43	6.90	7.16
20-24	100.00	62.52	24.56	7.46	5.46
25-44	100.00	66.98	20.78	8.29	3.95
45-54	100.00	69.48	18.16	9.13	3.23
55-64	100.00	66.35	20.66	9.11	3.88
65 and over	100.00	64.12	22.09	7.27	6.52
<i>Pattern of change in activity rates 1950-1960</i>					
0-14	120.68	121.62	84.75	121.17	176.47
15-19	95.22	96.13	91.53	96.85	97.14
20-24	99.51	99.36	99.77	101.00	98.26
25-44	100.12	100.26	99.79	100.11	99.49
45-54	96.28	95.78	96.24	99.13	99.10
55-64	82.08	78.98	89.42	81.41	97.73
65 and over	71.74	71.98	68.68	56.88	96.27
Females					
<i>Proportion of labour force in each age group</i>					
0-14	100.00	59.47	19.50	9.75	11.28
15-19	100.00	67.89	20.28	6.76	5.07
20-24	100.00	65.25	21.99	8.05	4.71
25-44	100.00	63.45	21.33	10.55	4.67
45-54	100.00	63.35	21.21	10.77	4.67
55-64	100.00	59.79	24.39	10.27	5.55
65 and over	100.00	56.75	27.36	8.13	7.76
<i>Pattern of change in activity rates 1950-1960</i>					
0-14	75.93	70.21	61.68	116.13	96.05
15-19	105.14	113.86	79.34	99.40	99.30
20-24	98.26	99.62	90.69	104.36	112.00
25-44	108.48	116.09	82.39	114.65	110.36
45-54	87.63	87.82	75.91	104.55	99.40
55-64	78.66	79.75	68.50	84.63	100.60
65 and over	80.23	95.95	54.18	52.20	86.53

TABLE 10
Temperate South America: projections of sex-age-specific activity rates for 1960-1970

Age group	Regional rates in 1960	Ratio changes of countries (1950-1960) ^a	First estimate of activity rates	Ratio changes of selected regions ^b	Estimate of activity rates based on ratio changes of selected regions	Second estimate of activity rates ^b	Third estimate of activity rates ^c
(1)	(2)	(3)	(4) = (2) × (3)	(5)	(6) = (2) × (5)	(7) = [(4) + (6)] : (2)	(8)
<i>Males</i>							
0-14	2.42	120.68	2.92	59.68	1.44	2.18	2.10
15-19	69.84	95.22	66.50	85.91	60.00	63.25	63.24
20-24	91.03	99.51	90.58	97.24	88.52	89.55	89.54
25-44	97.25	100.12	97.37	99.99	97.24	97.31	97.75
45-54	91.52	96.23	88.12	99.11	90.71	89.42	89.51
55-64	69.10	82.08	56.72	97.16	67.14	61.93	62.21
65 and over . . .	41.03	71.74	29.43	83.55	34.28	31.86	31.82
<i>Females</i>							
0-14	0.96	75.93	0.68	61.36	0.59	0.64	0.63
15-19	30.38	105.14	31.94	101.85	30.94	31.43	31.41
20-24	37.40	98.26	36.75	112.95	42.24	39.47	39.47
25-44	25.33	108.48	27.48	109.80	27.81	27.63	27.73
45-54	18.93	87.63	16.59	111.27	21.06	18.81	16.92
55-64	12.18	78.66	9.58	108.86	13.26	11.41	11.39
65 and over . . .	5.89	80.23	4.73	92.05	5.42	5.06	4.98

^a Weighted average (see table 9).

^c Aggregate of projections of component countries (see tables 13 and 14).

^b Japan, Southern Europe and Southern Africa for males; Southern Europe for females (see table 11).

TABLE 11
Pattern of change in male and female age-specific activity rates in selected regions: 1950-1960

Age group	Males				Females			
	Total ^a	Japan	Southern Europe	Southern Africa	Total	Japan	Southern Europe	Southern Africa
<i>Regional composition of the labour force in 1960</i>								
0-14	100.00	6.58	82.58	10.84	100.00	5.57	86.78	7.65
15-19	100.00	39.20	50.89	9.91	100.00	53.27	39.55	7.18
20-24	100.00	42.95	48.46	8.59	100.00	56.97	37.30	5.73
25-44	100.00	41.17	51.87	6.96	100.00	57.90	37.81	4.29
45-54	100.00	37.76	56.70	5.54	100.00	58.12	38.64	3.24
55-64	100.00	39.99	54.97	5.04	100.00	58.13	39.15	2.72
65 and over . .	100.00	42.00	53.31	4.69	100.00	57.07	41.21	1.72
<i>Patterns of changes observed during 1950-1960</i>								
0-14	59.68	133.33	55.08	50.00	n.a. ^b	n.a.	61.36	n.a.
15-19	85.91	81.41	88.67	89.56	n.a.	n.a.	101.85	n.a.
20-24	97.24	97.13	97.00	99.05	n.a.	n.a.	112.95	n.a.
25-44	99.99	100.82	99.42	99.34	n.a.	n.a.	109.80	n.a.
45-54	99.11	100.84	97.93	99.30	n.a.	n.a.	111.27	n.a.
55-64	97.16	102.09	93.55	97.34	n.a.	n.a.	108.86	n.a.
65 and over . .	83.55	97.35	73.27	76.73	n.a.	n.a.	92.05	n.a.

^a The total pattern of change in activity rates 1950-1960 is the weighted average of the regional changes.

^b n.a. = not applicable.

(iii) A third estimate of the activity rates of the region is obtained by computing the average activity rates for 1970 from the individual weighted rates for each of the countries for that year. These rates are shown in tables 12, 13 and 14 and projections for the region as a whole for 1970 in column 8 of table 10.

In general, the same procedure is applied to determine the regional sex-age-specific activity rates for 1980: the 1960 and 1970 figures for activity rates and economically active population in each of the component countries of a region provide the basic data for all three estimation methods described earlier. In the second estimate regional patterns of change for two periods, 1950-1960 and 1960-1970, are taken into account. The regional activity rates for 1965 and 1975 are derived by first fitting curves to the 1960 basic data and to the 1970 and 1980 projected sex-age-specific activity rates for each of the component countries of the region and then aggregating the results to obtain a regional average.

(b) National projections

Projections of national sex-age-specific activity rates for 1960-1970 are produced by linking national activity rates to regional patterns of change in activity rates. The regional patterns of change for 1950-1960 are used as models for patterns of change in the level of sex-age-specific activity rates over a ten-year period. The selection of regional models to be used for projecting the activity rates of a given country is made primarily on the basis of: similarity of the country's level of

economic development to that of the models at the base date — 1960; similarity of the sex-age-specific activity rates at the base date — 1960; and similarity in the trends of these levels during 1950-1960. The national values so computed are plotted on a graph depicting the twenty-three regions. The nearest region, or cluster of regions, to the country's position on the graph are selected as the most plausible models. Their plausibility is further tested by projecting the national activity rate for 1950-1960 and comparing the findings with the known data for 1960. Other things being equal, the geographical region within which the country falls is usually selected for linkage and projection of the national sex-age-specific activity rates; the figure opposite illustrates the application of the procedure to the countries of temperate South America.

The projection of activity rates in a country is obtained by linking the national data to the corresponding sex-age-specific regional data. The formula used for the projection is:

$$\frac{R_{t_1}}{R_t} \times n_t = n_{t_1}$$

in which R represented the regional rates (model), n the national rates (country), t the beginning of the projection period (1960) and t_1 the end of the projection period (1970). The national activity rates for a given sex-age group at the beginning — 1960 and at the end — 1970 — of the projection period are plotted on a graph together with the activity rates of the model (region) for the same sex-age group; the national activity rates are

TABLE 12
Chile: projections of activity rates, 1960-1980, calculated by the extrapolation method of the International Labour Office

Age group	Regional* activity rates			Activity rates in Chile				
	Observed (1960)	Projected (1980)	Ratio: increase or decrease	Observed (1960)	Projected (1980)	Interpolated		
	(1)	(2)	(4) = (3) : (2)	(5)	(6) = (5) (4)	(1965)	(1970)	(1975)
						(7)	(8)	(9)
Males								
0-14	2.5	1.5	60.0	2.3	1.2	2.0	1.8	1.5
15-19	70.4	65.0	92.3	61.7	56.9	60.5	59.3	58.1
20-24	92.2	86.0	93.3	91.6	85.5	90.1	88.5	87.0
25-44	97.5	97.0	99.5	96.9	96.9	96.9	96.9	96.9
45-54	91.7	93.0	101.5	90.0	92.1	91.2	91.5	91.8
55-64	67.4	65.0	96.4	80.6	77.8	79.9	79.2	78.5
65 and over	40.4	30.0	74.3	51.4	38.2	48.1	44.8	41.5
Females								
0-14	1.0	0.7	70.0	0.7	0.4	0.6	0.5	0.4
15-19	30.1	30.0	99.7	23.5	24.7	23.8	24.1	24.4
20-24	37.8	40.0	105.8	32.4	35.5	33.2	33.9	34.7
25-44	25.8	30.0	116.3	24.4	28.8	25.5	26.6	27.7
45-54	19.5	23.0	117.9	20.4	23.8	21.2	22.1	23.0
55-64	12.4	12.0	96.8	15.3	14.7	15.1	15.0	14.9
65 and over	5.1	4.0	78.4	7.9	6.0	7.4	7.0	6.5

* Temperate South America: Argentina, Chile, Paraguay and Uruguay.

TABLE 13

Temperate South America: projections of population, labour force and activity rates, by age group to 1970 (mid-year)

MALES

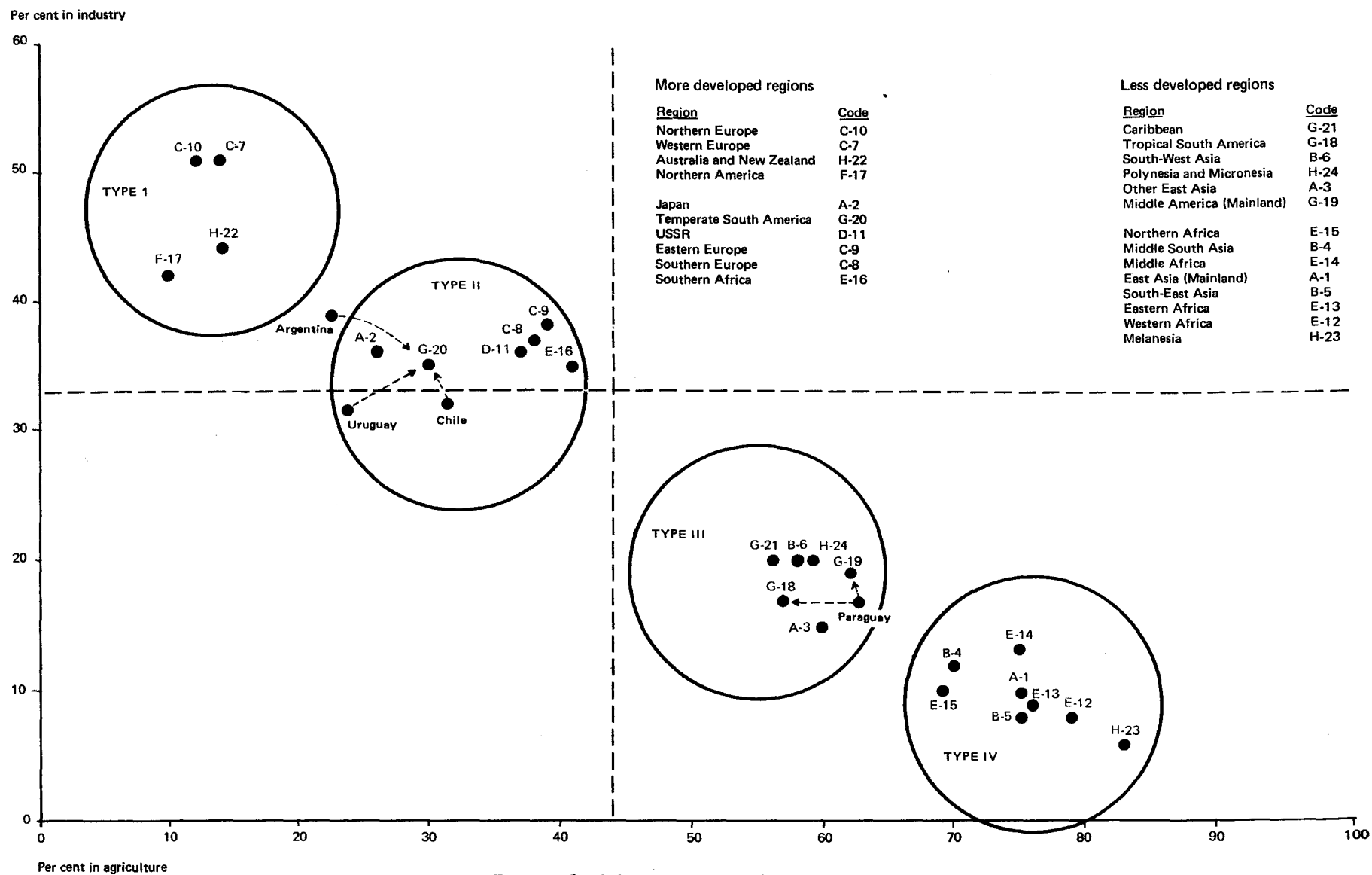
Area	Source	Total	Age group						
			0-14	15-19	20-24	25-44	45-54	55-64	65 and over
Population (thousands)									
Argentina	1970	12,137.4	3,510.5	1,107.9	1,016.7	3,387.5	1,313.3	973.0	828.5
Chile	1970	4,921.0	2,000.0	508.0	423.0	1,171.0	370.0	250.0	199.0
Paraguay	1970	1,153.3	519.0	130.1	108.5	250.3	68.4	42.5	34.0
Uruguay	1970	1,438.0	415.0	119.0	108.0	397.0	163.0	127.0	109.0
TOTAL . . .	1970	19,649.7	6,444.5	1,865.0	1,656.2	5,205.8	1,914.7	1,392.5	1,170.5
Labour force (thousands)									
Argentina	1970	6,982.2	71.3	723.7	902.6	3,298.7	1,170.0	569.4	246.5
Chile	1970	2,448.2	36.0	283.7	381.0	1,159.0	328.5	180.6	79.4
Paraguay	1970	584.2	15.7	96.7	100.4	244.4	66.3	39.2	21.5
Uruguay	1970	825.4	12.4	75.3	99.0	386.8	149.0	77.8	25.1
TOTAL . . .	1970	10,840.0	135.4	1,179.4	1,483.0	5,088.9	1,713.8	867.0	372.5
Activity rates									
Argentina	1970	57.53	2.03	65.32	88.78	97.38	89.09	58.52	29.75
Chile	1970	49.75	1.80	55.85	90.07	96.94	88.78	72.23	39.92
Paraguay	1970	50.65	3.02	74.34	92.54	97.66	96.99	92.19	63.37
Uruguay	1970	57.40	2.99	63.29	91.70	97.43	91.40	61.28	23.02
TOTAL . . .	1970	55.17	2.10	63.24	89.54	97.75	89.51	62.26	31.82

TABLE 14

Temperate South America: projections of population, labour force and activity rates, by age group to 1970 (mid-year)

FEMALES

Area	Source	Total	Age group						
			0-14	15-19	20-24	25-44	45-54	55-64	65 and over
<i>Population (thousands)</i>									
Argentina	1970	11,912.5	3,372.9	1,068.5	976.9	3,210.7	1,321.4	1,038.3	923.8
Chile	1970	5,048.0	1,958.0	497.0	430.0	1,215.0	413.0	283.0	252.0
Paraguay	1970	1,168.7	507.5	128.0	104.4	259.0	75.5	51.0	43.3
Uruguay	1970	1,448.0	400.0	117.0	108.0	400.0	166.0	127.0	130.0
TOTAL . . .	1970	19,577.2	6,238.4	1,810.5	1,619.3	5,084.7	1,975.9	1,499.3	1,349.1
<i>Labour force (thousands)</i>									
Argentina	1970	2,045.9	22.6	374.2	409.0	864.3	231.0	104.1	41.1
Chile	1970	742.1	8.8	121.0	147.7	323.1	83.9	40.7	17.1
Paraguay	1970	197.4	5.3	37.4	36.6	84.5	19.9	9.8	3.9
Uruguay	1970	283.9	3.9	36.0	45.8	138.3	39.1	16.1	4.8
TOTAL . . .	1970	3,269.3	40.6	568.6	639.1	1,410.2	373.9	170.7	67.2
<i>Activity rates</i>									
Argentina	1970	17.17	0.65	35.02	41.87	26.92	17.48	10.03	4.48
Chile	1970	14.70	0.44	24.35	34.25	26.59	20.32	14.38	6.79
Paraguay	1970	16.89	1.04	29.21	35.08	32.63	26.41	19.16	8.97
Uruguay	1970	19.61	0.95	30.79	42.43	34.57	23.54	12.68	3.67
TOTAL . . .	1970	16.70	0.63	31.41	39.47	27.73	18.92	11.39	4.98



then derived by fitting to the national data a curve similar to that yielded by the model. The result of this extrapolation in the case of Chile is shown in table 12.

In certain cases, particularly when computing activity rates for the female population, the national data may be extrapolated on the basis of more than one regional model. Female activity rates for Chile, for example, were projected by linkage to the projected trends of two regions, a national curve being plotted at one fourth of the distance between "temperate South America" and "tropical South America". A similar procedure was followed when the levels of activity rates and economic development were more closely paralleled by those of another region than by those observed in the geographical region in which the country was situated. Again, activity rates computed by the above procedure may be further adjusted if adequate data, such as data on urban and rural population, intercensal surveys, or information on economic development changes, educational policy and future pension policy are available.

The projected national sex-age-specific activity rates for 1970 obtained by the above procedures are then applied to the population projections for the countries concerned in order to derive the number of economically active persons in each sex-age group. The tabulations for temperate South America and its component countries are shown in tables 13 and 14; experience in using data for the twenty-three geographical regions as models has shown their usefulness.⁸ There is evidence, however, that a reclassification of individual countries into a certain number of model groups — irrespective of their geographical situation — on the basis of the similarity of the demographic, economic and other relevant factors which affect their activity rates would provide more refined results than those obtained with the present United Nations classification method.

B. CORRELATION METHODS

Some of the extrapolation methods described above can be used if statistical data are available which record the pattern of sex-age-specific activity rates observed in the past and from which fairly consistent trends emerge. Naturally, even in such cases it may be desirable to introduce adjustments for those age groups whose activity rates are liable to be affected by specific developments which are known or can be anticipated, such as changes in the compulsory education age range. In many developing countries, however, the proportions of economically active persons of both sexes in each age group cannot be projected into the future on the basis of trends observed in the past, owing to the absence or

inadequacy of comparable historical data. Another possible approach is to employ regression analysis. Its use requires that consideration first be given to whether the data for the regions — or zones or districts — of the country indicate a close relationship between the activity rates and certain characteristics of economic and social development, or whether the estimate of future activity rates can be compared with the data of another country or other countries: the advantage of the former method is that it is based solely on the data for the country concerned; the second method can be used where the other proves unsuitable.

Methods of this kind have been used for the manpower projections recently prepared for certain countries by the United Nations and the specialized agencies, and by other research organizations and institutes. Some of them are described below.

1. *Method based on the existence of correlations between the activity rates of the population and specified characteristics of economic development in various regions of a country*

The different stages of economic development obtaining in individual geographical regions of a particular country at a given time gives some idea of the dynamic and changing effect of the economic development process on the activity rates of various population groups. For this reason the future trend of the activity rate of the country as a whole is assumed to follow a pattern similar to that of the activity rates of the various regions of the country, measured from the least developed to the most developed.

(a) *Example of projections of labour supply for Central America, Panama and Mexico, 1950-1980*⁹

The basic assumption is that there is a close relationship between a country's level of industrialization and the sex-age-specific activity rates of its population. Since the development of industry is unequal in different regions of the country, the regional activity rates are necessarily different. In order to measure this correlation quantitatively, means must be found to measure the level of industrialization. It was accepted that the rate of industrialization is correctly represented by the proportion of the economically active population engaged in non-agricultural occupations. Accordingly the relationship between that rate and the sex-specific activity rates was analysed (see table 15). The correlation coefficient thus obtained is significant, the correlation being positive for females and negative for males.

The rates of industrialization which should be attained in 1980 were then selected for each country. Sex-specific activity rates for 1980 were computed from the results obtained by the analyses set out above. These activity rates were then distributed by age, assuming the continuance of the 1950 ratio of the

⁸ Inverse activity rate projections carried out with a view to "predicting" 1950 rates from 1960 data show that the average error with this method is less than 2 per cent for a decennial projection of patterns of change in the economically active population, as compared with 10 per cent or more when activity rates are assumed to be constant.

⁹ *Human Resources of Central America, Panama and Mexico, 1950-1980, in relation to some aspects of Economic Development* (United Nations publication, Sales No.: 60.XIII.1).

TABLE 15

Correlation and regression coefficients for economically active proportion of the population, by sex, in relation to level of industrialization in selected Central American countries, Panama and Mexico (1950)

Country and sex ^a	Correlation coefficient	Regression equations ^b	
		$y = a - bx$	$y^1 = a^1 + b^1x$
Costa Rica			
Males	-0.71	$y = 95,188 - 0.100 x$	
Females	+0.96	$y^1 = 4,310 + 0.251 x$	
El Salvador			
Males	-0.74	$y = 87,650 - 0.093 x$	
Females	+0.92	$y^1 = 3,276 + 0.356 x$	
Guatemala			
Males	-0.46	$y = 80,220 - 0.70 x$	
Females	+0.76	$y^1 = 4,812 + 0.182 x$	
Nicaragua			
Males	-0.88	$y = 99,410 - 0.138 x$	
Females	+0.72	$y^1 = 6,680 + 0.234 x$	
Panama			
Males	-0.88	$y = 83,592 - 0.101 x$	
Females	+0.88	$y^1 = 8,397 + 0.226 x$	
Mexico			
Males	-0.86	$y = 93,434 - 0.139 x$	
Females	+0.76	$y^1 = 4,010 + 0.189 x$	

SOURCE: *Human Resources of Central America, Panama and Mexico, 1950-1980, in relation to some Aspects of Economic Development* (United Nations publication, Sales No.: 60.XIII.1).

^a In Costa Rica and Mexico the economically active percentage of the population is the male or female population of 12 years and over; in El Salvador and Panama, of 10 years and over; in Nicaragua, of 14 years and over; and in Guatemala, of 7 years and over.

^b Explanation of symbols: y = percentage of economically active males; y^1 = percentage of economically active females; and x = percentage of population engaged in non-agricultural occupations. The data for these percentages were computed by provinces or departments in the specified Central American countries, of Panama, and by states in Mexico, and were taken from the 1950 population censuses of the respective countries.

activity rates of each age group to the activity rates for the total population of each sex. Next, adjustments were then made for young people in the 10-14 and 15-19 age groups, and for persons aged 65 and over, to take account of the probable decline, in relation to the first estimate, in the future activity rates for those age groups. For the other age groups, however, the results of the computation were regarded as valid.

A number of comments on the value of this method are called for:

- (i) The rate of industrialization cannot be clearly distinguished from the activity rate of the population. Auto-correlation is not excluded;
- (ii) The use of the square of the correlation coefficient (r^2) to indicate the percentage of the variance explained by the correlation is not very satisfactory except in a limited number of cases, namely, females in Costa Rica and El Salvador ($r^2 = 0.92$ and 0.85 respectively); for males in Nicaragua and females in Panama r^2 is only 0.78 . For other population groups studied results range from 0.5 to 0.6 . Lastly, for males in Guatemala r^2 is only 0.21 . Hence the explanatory value of the correlations is average or weak;

- (iii) The parameter b or b' , according to sex, is indicative, in the regression equation shown in table 15, of the intensity of the action of the explanatory variable on the explained variable. This parameter is moderately significant for females but it is nearly always very weak for males.

(b) *Projection of the economically active population of Japan, 1965-1985* ¹⁰

A generally similar method was applied in the case of Japan, but there the analysis was more precise, with greater age group detail. The first step was a relatively detailed analysis of activity rate trends observed in the past. This analysis showed that industrialization, like increases in *per capita* income and other indicators of rising levels of living, tended to be associated with decreasing rates of economic activity. Social and institutional changes which may contribute to changes in activity rates were also taken into consideration and account was taken of the possible effect of aggregate labour demand in relation to a given target to be attained at the end of the projection period. After this comprehensive study of the trends observed in the past and of possible future determinants of manpower, regression analyses were used. The percentages of non-agricultural workers, i.e. the numbers employed in the secondary and tertiary sectors, were regarded as independent variables, and the sex-age-specific activity rates as the dependent variables. The regression equations were based on 1960 data for the forty-six administrative districts (prefectures).

It was anticipated that during the projection period, 1965-1985, the proportion of the labour force engaged in agriculture would diminish by about 60 per cent, falling from 32.5 per cent in 1965 to 13 per cent in 1985, and the estimates of activity rates for 1985 were made on the basis of this fundamental assumption. The values for the intermediate years were obtained by linear interpolation. However, in order to show the possible range of variations in future activity rates, three variants were prepared: variant A, based on constant activity rates at the levels recorded in the 1965 census; variant B, calculated by averaging variants A and C; and variant C, based on the assumption described above. The last variant was regarded as being the most plausible. It is interesting to note that it assumed a substantial reduction in activity rates, especially among females (see table 16).

2. Correlation applied to observed differences between countries

When it is not considered desirable to make projections by the methods described above or to use extrapolation methods because the trends observed in the past do not give an accurate picture of the evolution of the labour force, a substitute method can be used: it is based on the relationship between activity rates

¹⁰ Japan, Institute of Population Problems, op. cit.

TABLE 16
Japan: past and projected activity rates, 1930-1985

Sex and age group	Activity rates					Deviation from 1960 rates		
	1930 ^a	1955 ^b	1960	1965 ^b	1985	1930	1965	1985
Males								
Total	89.0	82.6	85.0	83.4	83.5	4.0	-1.6	-2.5
15-19	78.4	54.3	50.7	38.6	40.0	27.7	-12.1	-10.7
20-24	91.8	88.1	86.8	87.1	85.5	5.0	0.3	-1.3
25-29	96.7	96.2	96.0	97.9	95.9	0.7	1.9	-0.1
30-34	98.0	97.0	97.1	98.6	65.8	0.9	1.5	-0.3
35-39	98.1	97.3	97.2	98.4	97.2	0.9	1.2	0.0
40-44	97.9	97.4	97.1	98.3	97.2	0.8	1.2	0.1
45-49	97.0	97.0	96.7	98.0	96.8	0.3	1.3	0.1
50-54	95.3	95.5	95.1	97.2	95.2	0.2	2.1	0.1
55-59	91.9	91.1	89.5	93.8	88.4	2.4	4.3	-1.1
60-64	85.3	82.4	81.9	85.3	78.2	3.4	3.4	-3.7
65 and over	63.0	56.4	54.5	55.1	39.2	8.5	0.6	-15.3
Females								
Total	48.8	48.1	50.9	49.8	32.5	-2.1	-1.1	-18.4
15-19	61.7	50.1	48.9	37.6	40.0	12.8	-11.3	-8.9
20-24	53.7	68.2	68.4	69.7	65.0	-14.7	1.3	-3.4
25-29	46.5	51.8	50.1	46.4	38.4	-3.6	-3.7	-11.7
30-34	48.7	49.6	50.7	48.0	32.8	-2.0	-2.7	-17.9
35-39	51.9	53.4	54.5	58.3	36.3	-2.6	-3.8	-18.2
40-44	53.7	55.5	57.1	62.1	39.0	-3.4	5.0	-18.1
45-49	53.5	54.4	56.1	62.6	37.2	-2.6	6.5	-18.9
50-54	50.7	51.3	51.9	57.3	32.1	-1.2	5.4	-19.8
55-59	45.0	45.7	45.8	50.1	25.8	-0.8	4.3	-20.0
60-64	35.3	38.4	39.1	39.3	16.8	-3.8	0.2	-22.3
65 and over	18.5	20.6	21.4	17.6	5.3	-2.9	-3.8	-16.1

SOURCE: Japan, Institute of Population Problems, *Estimates of Future Labour Force Population in Japan for October 1 from 1965 to 1985, Estimated in December 1966* (Tokyo, 1967), pp. 4 and 17.

^a Based on the "gainful worker" concept.

^b Based on a 1 per cent sample.

and certain economic and social variables which are assumed to have an effect on future rates of economic activity, particularly among young people and those in the older age groups. In order to prepare manpower projections for the Philippines,¹¹ for example, data from some thirty countries were examined with a view to measuring by correlation coefficients the association between:

(a) The age-specific activity rates for males in the youngest and oldest age groups, and the percentages of the male labour force engaged in agriculture. The results were as follows:

Males 10-14 years	+0.64
Males 15-19 years	+0.62
Males 55-64 years	+0.86
Males 65 years and over	+0.82

(b) The age-specific activity rates for males in these age groups and the percentage of the population 10 years

of age and over who were literate. The results were as follows:

Males 10-14 years	-0.77
Males 15-19 years	-0.46
Males 55-64 years	-0.70
Males 65 years and over	-0.79

(c) The male and female activity rates for the youngest age groups and the percentage of persons in those age groups who were attending school. The results were as follows:

Males 10-14 years	-0.87
Males 15-19 years	-0.94
Females 10-14 years	-0.54

(d) The activity rates of young persons and the combined factors of school attendance and degree of industrialization (as measured by the percentage of active males in agriculture). The results were as follows:

Males 10-14 years	+0.89
Males 15-19 years	+0.94
Females 10-14 years	+0.63

Thus negative correlations were found between school attendance and activity rates in the young age groups, and also between literacy and the sex-age-specific

¹¹ *Population Growth and Manpower in the Philippines*, a joint study by the United Nations and the Government of the Philippines, 1960 (United Nations publication, Sales No.: 61.XIII.2), pp. 19-23 and 54-66.

activity rates. On the other hand, fairly high positive correlations were found between the importance of agriculture as a field of employment and activity rates for all the age groups tested. The multiple correlation coefficients between the activity rates of young persons and school attendance combined with the degree of industrialization were very significant for boys and adolescents of the two age groups 10-14 and 15-19, and were fairly high for girls aged 10 to 14. The regression equations used to estimate future activity rates were therefore based on the association with prospective changes in the percentage of the labour force engaged in agriculture in the case of males in the age groups 55-64 and 65 and over, and on the percentages attending school and engaged in agriculture, in the case of males in the 10-14 and 15-19 age groups and females aged 10-14.¹² The regression equations are given below:

$$\begin{aligned} \text{Males 10-14 years} & \dots x_1 = 42.20 + 156 x_2 - 0.488 x_3 \\ \text{Males 15-19 years} & \dots x_1 = 89.68 + 0.026 x_2 - 0.812 x_3 \\ \text{Females 10-14 years} & \dots x_1 = 6.34 + 0.072 x_2 - 0.071 x_3 \\ \text{Males 55-64 years} & \dots Y = 79.75 + 0.178 x \\ \text{Males 65 years and over} & Y = 28.33 + 0.684 x \end{aligned}$$

In these equations x_1 represents the percentage economically active in the given age group; x_2 the percentage of economically active males engaged in agriculture; x_3 the percentage in the given age group attending school; Y the percentage economically active in the given age group; and x the percentage of economically active males engaged in agriculture.

The results obtained were then adjusted as follows:

(a) For males under 20 years (10-14 and 15-19 years) and for females under 15 years, the activity rates were projected by means of a multiple regression equation, bearing in mind the probable future trend of school attendance and industrialization. The percentages of young people attending school were projected to the target year on the basis of trends observed in the past. Since a high level of school attendance (among young people 10-14 years) already obtained at the beginning of the projection period, it was assumed that the rate of increase would slacken. For adolescents, the 15-19 year group, it was assumed that the past rate of increase would be maintained;

(b) For males aged 20 to 24, it was assumed that the proportion of those attending school at the beginning of the projection period would increase in the future at the same rate as that of the 18-19 age group in the previous two decades. That assumption was made because of the lack of international data on school attendance for the 20-24 age group and because of the absence of a close association between the activity rate and the degree of industrialization;

(c) For males aged 25 to 55, it was assumed that the activity rates would remain constant until the end of

the projection period, owing to the relative stability of the activity rates of males of these age groups, as shown by the national census data and the data of other countries;

(d) For females over 15 years, no close correlation was found between their activity rates and industrialization or school attendance. Consequently, it was assumed that the activity rates of females of all ages over 15 would remain constant until the target year, in both urban and rural sectors;

(e) The industrialization trend is measured by the percentage of the labour force engaged in agriculture, and this was assumed to fall slightly — from 68.8 to 67.3 per cent — during the first five years of the projection period (1957-1962), which in fact represents a very moderate rate of industrialization. For the latter part of the projection period, a slightly more rapid rate of industrialization was adopted: it was assumed that the percentage of the labour force engaged in agriculture would fall to 65.3 per cent in 1967, to 62.8 per cent in 1972 and 59.7 per cent in 1977. The assumptions used in this projection were arbitrary and a different assumption might have been adopted for nearly every part of the projection period, with somewhat different results.

C. MATRIX REPRESENTATION OF FUTURE LABOUR FORCE TRENDS

Matrix computation enlarges the scope of population projection work, since it enables the combined action of different factors which may affect the evolution of the population to be assessed; a large number of variables can be introduced. Hence such procedures can be very useful in projections of the economically active population, which are influenced by a large number of factors. Nevertheless, while the method is obviously useful, its limitations must be clearly understood: the method is merely a helpful technical device for making the computations for a projection of the economically active population. The value of the computations depends, however, on the assumptions made as to the various factors which play a role in the evolution of the economically active population. Matrix computation in no way helps to define these assumptions; it simply makes it possible better to determine their effect on the numbers of the population seeking employment.

The principles of this new technique and methods for applying it will be described by reference to an example: that of the projection of labour supply in Mexico for 1965-1985.¹³ This projection was made by sex and by age, a distinction being made between the urban and rural economically active populations.

In view of the constraints of the method in question, the inactive population, including children, must also

¹² For males over 55, the trend of school attendance is not applicable, so that the regression equation was limited to the association between percentages of the labour force and industrialization.

¹³ This example is taken from the study by L. Tabah, "Représentations matricielles de perspectives de population active", *Population*, No. 3, May-June 1968, pp. 437-476.

be estimated and distributed between the urban and rural populations. The model represents the total population and shows its evolution at all ages; it must therefore allow for future births.

Before the types of assumption needed for the functioning of the model, and its principles and operation are described, the meaning of the symbols used must be given: the number of males of age x , economically active and urban, at the beginning of the projection, will be denoted by $t^m x$; m ; a ; u . To represent the number of females, it is sufficient to replace m by f . To denote the inactive, i is substituted for a , and to denote the number of rural workers, r is substituted for u . The time reference is represented by the letter t placed before the letter n .

1. Basic assumptions

(a) Probabilities of accession to and separation from activity or inactivity

These probabilities, represented by the sign θ , were established on the basis of information derived from population censuses according to the following formulae, in which a_x represents the activity rate at age x for the base year:

Probability of accession to activity:

$$\theta_{i,a} = \frac{a_{x+1} - a_x}{1 - a_x}$$

Probability of separation from activity:

$$\theta_{a,i} = \frac{a_x - a_{x+1}}{a_x}$$

Probability of non-separation from inactivity:

$$\theta_{a,i} = \frac{1 - a_{x+1}}{1 - a_x}$$

Probability of non-separation from activity:

$$\theta_{a,a} = \frac{a_{x+1}}{a_x}$$

(b) Probabilities of migration

The probabilities of migration, represented by the symbol μ , were calculated as between urban and rural areas and by sex, but without using differential migration rates, which show whether persons were active or inactive in their areas of origin before migration. These calculations were prepared on the basis of census results.

(c) Probabilities of survival

The probable survival ratios were calculated in the urban and rural areas, without allowing for differential mortality depending on active and inactive status but assuming that migrants were subject to the pattern of mortality of the area from which they came. These probabilities are represented by the symbol P .

(d) Probabilities of births

Births during the projection period must be calculated because the method projects the evolution not only of

the active population, but also of the inactive population. No differential fertility, depending on whether the women are active or inactive, was assumed. However, births must be distributed between future births to urban and rural, migrant and non-migrant women, and they must be distributed by sex. A calculation of this type, applied to urban females in a five-year projection of the Mexican population in 1960-1965, is cited here as an example.

The number of births of both sexes to urban females in the age group x to $x + 4$ during the year 1960 can be estimated by the following formula, in which fertility is represented by the sign φ :

$$(60^n x, x + 4; f; u) \cdot (60 \varphi x, x + 4; u).$$

This is only an approximation, because it is the number of urban women of age $x, x + 4$ at 30 June 1960 which should have been multiplied by $60 \varphi x, x + 4; u$. Births to urban women not emigrating during the whole projection period, in the absence of mortality, amount to:

$$(60^n x, x + 4; f; u) \cdot (\mu x, x + 4; f; u, u) \cdot (60 \varphi x, x + 4; u).$$

The number of births at the end of the period, i.e. in 1964, in this group of women can be estimated by the following formula:

$$(60^n x, x + 4; f; u) \cdot (P x, x + 4; f; u) \cdot$$

$$(\mu x, x + 4; f; u, u) \cdot (65 \varphi x + 5, x + 5 + 4; u).$$

This, too, is only an approximation, because it is the number of urban women who have not emigrated and who, by 30 June 1964, formed the age group $x + 4, x + 4 + 4$ which should have been multiplied by rate $60 \varphi x, x + 4, x + 4 + 4$ to find the births in this group during the year 1964. Thus the average annual number of births between 1960 and 1964 can be estimated as the arithmetic mean of the last two expressions:

$$1/2 [(60^n x, x + 4; f; u) (\mu x, x + 4; f; u)]$$

$$[(60 \varphi x, x + 4; u) + (65 \varphi x + 5 + 4; u) (P x, x + 4; f; u)].$$

To obtain the total number of births during the five years of the period for the same group of women, this quantity is multiplied by 5; then, to obtain male births alone, the sex ratio k is applied. To estimate the number of boys surviving on 1 January 1965, for example, it is sufficient to apply the projected male survival ratio for urban populations.

2. Principles of the matrix

The purpose of the matrix is to represent either entries through birth or expected future movements for each sex as between the economically inactive and active populations, and the urban and rural populations, or the expected movements within each of these groups on account of aging. In projecting these movements, the degree of detail as regards the ages of the population can be varied: in table 17, in order to simplify matters, only three age groups were used. Since there are three criteria — sex, active or inactive status, and urban or rural residence, there are eight possible initial situations, if age is not taken into con-

TABLE 17

Projection of the economically active population by sex and age with migration to and from rural and urban areas

Initial situation

		Active urban males			Inactive urban males			Active urban females			Inactive urban females			Active rural males			Inactive rural females			Active rural females			Inactive rural females			Vector describing the initial situation	Sub-vectors
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24		
Situation at end of period	Active urban males	1																								$0^a1; m; a; u$	$0^N m; a; u$
		2	m_2^1	M_1^1		m_2^4	M_1^2		M_1^3		M_1^4			m_2^{13}	M_1^5		m_2^{16}	M_1^6		M_1^7			M_1^8			$0^a2; m; a; u$	
		3		m_3^2			m_3^5								m_3^{14}			m_3^{17}								$0^a3; m; a; u$	
	Inactive urban males	4						m_4^7	m_4^8	m_4^9	m_4^{10}	m_4^{11}	m_4^{12}							m_4^{19}	m_4^{20}	m_4^{21}	m_4^{22}	m_4^{23}	m_4^{24}	$0^a1; m; i; u$	$0^N m; i; u$
		5	m_5^1	M_2^1		m_5^4	M_2^2		M_2^3		M_2^4			m_5^{13}	M_2^5		m_5^{16}	M_2^6		M_2^7			M_2^8			$0^a2; m; i; u$	
		6		m_6^2			m_6^5								m_6^{14}			m_6^{17}								$0^a3; m; i; u$	
	Active urban females	7																								$0^a1; f; a; u$	$0^N f; a; u$
		8		M_3^1			M_3^2	m_8^7	M_3^3		m_8^{10}	M_3^4		M_3^5			M_3^6			m_8^{19}	M_3^7		m_8^{22}	M_3^8		$0^a2; f; a; u$	
		9							m_9^8		m_9^{11}									m_9^{20}			m_9^{23}			$0^a3; f; a; u$	
	Inactive urban females	10						m_{10}^7	m_{10}^8	m_{10}^9	m_{10}^{10}	m_{10}^{11}	m_{10}^{12}							m_{10}^{19}	m_{10}^{20}	m_{10}^{21}	m_{10}^{22}	m_{10}^{23}	m_{10}^{24}	$0^a1; f; i; u$	$0^N f; i; u$
		11		M_4^1			M_4^2	m_{11}^7	M_4^3		m_{11}^{10}	M_4^4		M_4^5			M_4^6			m_{11}^{19}	M_4^7		m_{11}^{22}	M_4^8		$0^a2; f; i; u$	
		12							m_{12}^8		m_{12}^{11}									m_{12}^{20}			m_{12}^{23}			$0^a3; f; i; u$	
	Active rural males	13																								$0^a1; m; a; r$	$0^N m; a; r$
		14	m_{14}^1	M_5^1		m_{14}^4	M_5^2		M_5^3		M_5^4			m_{14}^{13}	M_5^5		m_{14}^{16}	M_5^6		M_5^7			M_5^8			$0^a2; m; a; r$	
		15		m_{15}^2			m_{15}^5								m_{15}^{14}			m_{15}^{17}								$0^a3; m; a; r$	
	Inactive rural males	16						m_{16}^7	m_{16}^8	m_{16}^9	m_{16}^{10}	m_{16}^{11}	m_{16}^{12}							m_{16}^{19}	m_{16}^{20}	m_{16}^{21}	m_{16}^{22}	m_{16}^{23}	m_{16}^{24}	$0^a1; m; i; r$	$0^N m; i; r$
		17	m_{17}^1	M_6^1		m_{17}^4	M_6^2		M_6^3		M_6^4			m_{17}^{13}	M_6^5		m_{17}^{16}	M_6^6		M_6^7			M_6^8			$0^a2; m; i; r$	
		18		m_{18}^2			m_{18}^5								m_{18}^{14}			m_{18}^{17}								$0^a3; m; i; r$	
	Active rural females	19						m_{20}^7	M_7^3		m_{20}^{10}	M_7^4		M_7^5			M_7^6			m_{20}^{19}	M_7^7		m_{20}^{22}	M_7^8		$0^a1; f; a; r$	$0^N f; a; r$
		20		M_7^1			M_7^2													m_{20}^{20}			m_{20}^{23}			$0^a2; f; a; r$	
		21							m_{21}^8		m_{21}^{11}									m_{21}^{20}			m_{21}^{23}			$0^a3; f; a; r$	
	Inactive rural females	22						m_{22}^7	m_{22}^8	m_{22}^9	m_{22}^{10}	m_{22}^{11}	m_{22}^{12}							m_{22}^{19}	m_{22}^{20}	m_{22}^{21}	m_{22}^{22}	m_{22}^{23}	m_{22}^{24}	$0^a1; f; i; r$	$0^N f; i; r$
		23		M_8^1			M_8^2	m_{23}^7	M_8^3		m_{23}^{10}	M_8^4		M_8^5			M_8^6			m_{23}^{19}	M_8^7		m_{23}^{22}	M_8^8		$0^a2; f; i; r$	
		24							m_{24}^8		m_{24}^{11}									m_{24}^{20}			m_{24}^{23}			$0^a3; f; i; r$	

sideration.¹⁴ Each initial situation is expressed by a vector (see penultimate column of the table). To complete this initial structure, the vector is pre-multiplied by a square matrix containing the same number of rows and columns as the vector, i.e. eight, since there are eight possible situations. The matrix is divided into 64 sub-matrices. Each of them can be expressed by the formula M_{ij}^i , in which i denotes the final situation and j the initial situation. Age is not taken into account at this stage of the construction of the matrix. If, for example, three age groups are used, the number of sub-matrices becomes: $24 \times 24 = 576$.

Each sub-matrix represents movement from one of the eight possible initial situations—for example, active urban males—for a given age group—say, group 1—either to the next age group in the same situation or to a different situation (such as transfer of active urban males into the inactive urban males group). Such movements are not possible, of course, to every block in the matrix: for example, there can be no transfer of urban active females into the urban active males group, which would literally represent a change of sex. Of the 576 theoretical possible sub-matrices of table 17, only 112 can be filled in. They fall into three groups:

(a) Forty-eight sub-matrices correspond to entries into the population, i.e. births. These births derive from the four female groups: urban and rural females, active and inactive. The births are distributed among four possible groups, namely, males and females, urban and rural, all necessarily being inactive, since they are children;

(b) Sixteen sub-matrices record simple age shifts within individual active groups: m_2^1 , m_7^1 , m_{14}^{13} and m_{20}^{19} for movement from age group 1 to age group 2, and m_3^2 , m_8^2 , m_{15}^{14} and m_{21}^{20} for movements from group 2 to group 3. In the inactive groups, sub-matrices m_4^1 , m_5^1 , m_{12}^{11} , m_{17}^{16} , m_{18}^{17} , m_{23}^{22} and m_{24}^{23} represent the same age shifts;

(c) Sixteen sub-matrices represent changes as between inactivity and activity within either urban or rural areas:

Transitions from inactivity to activity:

$$m_2^4, m_5^5, m_8^{10}, m_{11}^{11}, m_{14}^{16}, m_{15}^{17}, m_{20}^{22}, m_{21}^{23};$$

Transitions from activity to inactivity:

$$m_5^1, m_6^2, m_{11}^7, m_{12}^8, m_{17}^{13}, m_{18}^{14}, m_{23}^{19}, m_{24}^{20};$$

(d) Thirty-two sub-matrices correspond to migrations from and to rural and urban areas. Some of these migrations are combined with changes in activity status, when migrants at the same time move out of inactive into active status or vice versa:

a. The following sub-matrices represent migrations without change in activity status: m_{14}^1 , m_{15}^2 , m_{17}^4 , m_{18}^5 , m_{20}^7 , m_{21}^8 , m_{23}^{10} , m_{24}^{11} , m_{12}^{13} , m_{13}^{14} , m_{16}^{15} , m_{17}^{16} , m_{19}^{17} , m_{20}^{18} , m_{22}^{19} , m_{23}^{20} ;

b. The remaining sub-matrices represent migration movements from and to urban and rural areas with an

accompanying change in activity status: m_{17}^1 , m_{18}^2 , m_{14}^4 , m_{15}^5 , m_{23}^7 , m_{24}^8 , m_{20}^{10} , m_{21}^{11} , m_{13}^{13} , m_{14}^{14} , m_{16}^{15} , m_{17}^{16} , m_{19}^{17} , m_{20}^{18} , m_{22}^{19} , m_{23}^{20} .

In practice it is not very likely that some of the situations represented will occur—that active urban males, for example, will become active rural males, since the movement is generally in the reverse direction (m_{14}^1 , m_{18}^2). On the other hand, the sub-matrices m_{18}^{13} and m_{14}^{14} , which record the drift of agricultural population to towns, are of very great practical importance.

3. Computation of the components of the matrix

The example used will again be the population of Mexico, broken down into five-year age groups and distributed by sex, urban and rural segments of the population, and economically active and inactive segments of the population. The way in which the formulae are constructed when this structure is to be moved forward in five-year stages is explained below. The meaning of the symbols used is given first:

$60^n x, x + 4; f; a; u$ is the number of active urban females of age $x, x + 4$ in 1960;

$60^n x, x + 4; f; a; r$, the number of active rural females of age $x, x + 4$ in 1960;

$60^n x, x + 4; f; i; u$, the number of inactive urban females of age $x, x + 4$ in 1960;

$60^n x, x + 4; f; i; r$, the number of inactive rural females of age $x, x + 4$ in 1960;

$60 \phi x, x + 4; u$ and $65 \phi x, x + 4; u$ are the fertility rates from age x to age $x + 4$ in urban areas in 1960 and 1965, no allowance being made, for lack of observed data, for differential fertility depending on activity status; the introduction of this factor would not, however, give rise to any difficulty;

$60 \phi x, x + 4; r$ and $65 \phi x, x + 4; r$, are the same rates for rural areas;

$Px, x + 4; f; u$ and $Px, x + 4; f; r$ are the probable survival ratios in urban and rural areas in 1960-1964 for females between the ages of x and $x + 4$ at 1 January 1960; here again no allowance is made for differential mortality depending on activity status, although this could be done;

$Pn; f; v$ and $Pn; f; r$ are the probable survival ratios of girls born in 1960-1964 in urban and rural areas, no allowance being made for differential mortality depending on whether the mothers are active or inactive;

$\theta x, x + 4; f; u, r$ represents the probabilities of migration—mortality being ignored—in 1960-1964 from urban to rural areas for females between the ages of x and $x + 4$ at 1 January 1960, no allowance being made for differential migration depending on activity status;

$\theta x, x + 4; f; r, u$ represents the same probabilities for migration in the opposite direction;

$\theta x, x + 4; f; i, a; u$ represents the probabilities for inactive urban females of age $x, x + 4$, of entering activity before $x + 5, x + 5 + 4$;

$\theta x, x + 4; f; i, i; u$ represents the probabilities for the same females of not leaving inactive status;

¹⁴ If we distinguish three age groups, as is done in table 17, there are twenty-four possible starting-points.

$\theta x, x+4; f; i, a; r$ and $\theta x, x+4; f; i, i; r$ represent the foregoing two probabilities for rural females;

$\theta x, x+4; f; a, i; u$ represents the probabilities, for active urban females of age $x, x+4$, of leaving active status before age $x+5, x+5+4$;

$\theta x, x+4; f; a, a; u$ represents the probabilities for the same female group of not leaving active status;

$\theta x, x+4; f; a, i; r$ and $\varphi x, x+4; f; a, a; r$ represent the foregoing two probabilities for rural females;

k is the masculinity proportion at birth;

all these expressions are in the same form when they concern males, except that the symbol m replaces f .

Each of the components of the sub-matrices can now be calculated.

Sub-matrix M_1^1 : urban active males remaining active and urban:

The components of the sub-diagonal m_2^1 and m_3^1 represent combinations of probabilities of survival in urban areas, probabilities for active urban males of not leaving active status and probabilities of not migrating, i.e.:

$$(Px, x+4; m; u) \cdot (\varphi x, x+4; m; a, a; u) \cdot (\varphi x, x+4; m; u, u).$$

Sub-matrix M_1^2 : inactive urban males entering activity in urban areas:

The components of the sub-diagonal m_2^2 and m_3^2 this time represent combinations of probabilities of survival in urban areas, probabilities for inactive urban males of entering activity and probabilities of not migrating from the urban sector, i.e.:

$$(Px, x+4; m; u) \cdot (\varphi x, x+4; m; i, a; u) \cdot (\varphi x, x+4; m; u, u).$$

The components of the other two other sub-matrices in the first row can easily be worked out:

Sub-matrix M_1^3 : active rural males migrating but remaining active:

$$(Px, x+4; m; r) \cdot (\varphi x, x+4; m; a, a; r) \cdot (\varphi x, x+4; m; r, u).$$

Sub-matrix M_1^4 : inactive rural males migrating and entering activity:

$$(Px, x+4; m; r) \cdot (\varphi x, x+4; m; i, a; r) \cdot (\varphi x, x+4; m; r, u).$$

Similarly, for the first two sub-matrices of the second row:

Sub-matrix M_2^1 : active urban males becoming inactive but not migrating:

$$(Px, x+4; m; u) \cdot (\varphi x, x+4; m; a, i; u) \cdot (\mu x, x+4; m; u, u).$$

Sub-matrix M_2^2 : inactive urban males remaining inactive but not migrating:

$$(Px, x+4; m; u) \cdot (\varphi x, x+4; m; i, i; u, u) \cdot (\mu x, x+4; m; u, u).$$

Sub-matrices M_2^3 and M_2^4 : survivors of male births to non-migrating active or inactive urban females:

The components of these two sub-matrices incorporate births occurring during the projection interval and

hence serve to replenish the population. The method of calculating these sub-matrices was described in the passages concerning basic assumptions. The formula used is:

$$(60^n x, x+4; f; u \cdot \frac{5k}{2} Pn; m; u \cdot \mu x, x+4; f; u, u)$$

$$(60^o x, x+4; u + 65^o x+5, x+5+4; u \cdot Px, x+4; f; u).$$

In these expressions, the coefficients of $60^n x, x+4; f; u$ are the components of the first row of the sub-matrix M_2^3 . The sum of the expressions for all the age groups ($x = 15, \dots, 45$) represents the total number of surviving male children of ages 0 to 4 years as of 1 January 1965. For the purpose of this calculation it was assumed that the migration of children born during the projection period could not occur independently of that of the mothers, so that the migration of mothers was identified with the migration of children. If these two migratory movements were assumed to be independent, the probability of migration of the mothers $\mu x, x+4; u, u$ would have to be replaced in the foregoing expression by that of the births $\mu n; m; u, u$ and the formula would be:

$$(60^n x, x+4; f; u \cdot \frac{5k}{2} Pn; m; u \cdot \mu n; m; u, u)$$

$$(60^o x, x+4; u + 65^o x+5, x+5+4; u \cdot Px, x+4; f; u).$$

Sub-matrix M_2^5 : active rural males becoming inactive and migrating:

$$(Px, x+4; m; r) \cdot (\varphi x, x+4; m; a, i; r) \cdot (\mu x, x+4; m; r, u).$$

Sub-matrix M_2^6 : inactive rural males remaining inactive and migrating:

$$(Px, x+4; m; r) \cdot (\varphi x, x+4; m; i, i) \cdot (\mu x, x+4; m; r, u).$$

Sub-matrices M_2^7 and M_2^8 : survivors of male births to migrating active or inactive rural females:

The same expression is used as for M_2^3 and M_2^4 , the symbol r being substituted for u in the mortality and fertility functions and for the first index u at the base of the migration function, i.e.:

$$\left(\frac{5k}{2} \cdot Pn; m; r x \cdot \mu x, x+4; f; r, u \right)$$

$$(60^o x, x+4; r + 65^o x+5, x+5+4; r \cdot Px, x+4; f; r).$$

The reader will easily find for himself the other components of the matrix, using similar reasoning.

The final result is shown in table 18 below.

D. LIMITATIONS OF THE METHODS DESCRIBED IN THIS CHAPTER

The methods described above project future sex-age-specific activity rates mechanically on the basis of past observed trends or on the basis of correlations established with the current distribution of activity rates in different parts of a country or in different countries. They have two potential drawbacks.

The reference period used in, for example, estimates by extrapolation, is often very short — five years in the example we gave for Japan. There are definite hazards involved in projecting the development of activity rates

over a twenty-year period by extrapolating from the observed trend for such a short period, inasmuch as the projection period is much longer than the reference period. This drawback is hard to eliminate. Many countries have information on trends in activity rates for only a short period, and even in those countries which have longer series, the data for the earlier years are difficult to handle because they relate to economic and social structures which have been made obsolete by technical advances or changing customs. Adjustments must therefore be made to the activity rates for the under-20 age groups and most certainly for the 65 and over age groups.¹⁵ One example of such adjustments has already been given for the Philippines.¹⁶ A second example which is cited below relates to Central America,

¹⁵ In some cases, however, pension schemes affect workers under the age of 65. That is true, in particular, of some of the highly developed countries.

¹⁶ *Population Growth and Manpower in the Philippines*, a joint study by the United Nations and the Government of the Philippines, 1960, (United Nations publication, Sales No.: 61.XIII.2), pp. 42-43.

Panama and Mexico;¹⁷ table 19 gives the principal results of that projection.

Downward adjustment for the 10-14 age group in 1980 was substantial but relatively slight for the 15-19 group. The main assumption for the 10-14 males was that by 1980 activity rates for that group for the country as a whole would be no greater than those prevailing in 1950 among the urban population. In other words, it was assumed that with the level of economic development that might be reached by 1980 the standards of school facilities and school enrolment for the 10-14 boys for the whole country would equal those for urban children in 1950. For males aged 15-19 the adjustment made some allowance for longer schooling, but not to the same degree. The activity rates for girls aged 10-14 were assumed to be approximately the same as those of 1950, since more employment opportunities for girls aged 13 and 14, resulting from increased urbanization,

¹⁷ *Human Resources of Central America, Panama and Mexico, 1950-1980, in relation to some Aspects of Economic Development* (United Nations publication, Sales No.: 60.XIII.1).

TABLE 18
Projection of the Mexican population (1960-1965): absolute numbers

	1960	1965	1970	1975	1980	1985
(Thousands)						
Economically active urban males	4,151.8 (11.5) *	5,279.8 (12.5)	6,636.2 (13.4)	8,329.8 (14.3)	10,364.9 (15.1)	12,753.9 (15.8)
Economically inactive urban males	4,728.6 (13.1)	6,100.3 (14.4)	7,633.5 (15.4)	9,405.0 (16.1)	11,509.2 (16.8)	14,032.4 (17.4)
Economically active urban females	1,391.2 (3.9)	1,646.2 (3.9)	2,016.5 (4.1)	2,540.8 (4.2)	3,224.4 (4.7)	4,092.5 (5.1)
Economically inactive urban females	7,982.3 (22.2)	10,098.9 (23.9)	12,514.0 (25.2)	15,293.5 (26.3)	18,638.2 (27.2)	22,490.0 (27.9)
Economically active rural males	4,569.1 (12.7)	4,924.1 (11.7)	5,293.2 (10.7)	5,715.2 (9.8)	6,186.3 (9.0)	6,702.8 (8.3)
Economically inactive rural males	4,518.4 (12.6)	4,842.7 (11.5)	5,307.3 (10.7)	5,850.0 (10.0)	6,444.2 (9.4)	7,137.6 (8.9)
Economically active rural females	519.3 (1.4)	562.4 (1.3)	615.9 (1.2)	675.6 (1.2)	781.7 (1.1)	889.7 (1.1)
Economically inactive rural females	8,142.6 (22.6)	8,804.1 (20.8)	9,586.4 (19.3)	10,480.4 (18.0)	11,445.6 (16.7)	12,508.3 (15.5)
TOTAL	36,003.3 (100.0)	42,258.5 (100.0)	49,603.1 (100.0)	58,290.2 (100.0)	68,594.5 (100.0)	80,608.1 (100.0)
Urban population	18,253.9 (50.7)	23,125.2 (54.7)	28,800.2 (58.1)	35,569.0 (58.9)	43,736.7 (63.8)	53,368.9 (66.2)
Rural population	17,749.4 (49.3)	19,133.3 (45.3)	20,802.8 (41.9)	22,721.2 (41.1)	24,857.8 (36.2)	27,238.4 (33.8)

* The figures in brackets represent the percentage of population in each category.

TABLE 19

Central America, Panama and Mexico: activity rates (1950 and 1980)

Sex and age	1950 census data						Projection for 1980					
	El Salvador	Costa Rica	Guatemala	Nicaragua	Panama	Mexico	El Salvador	Costa Rica	Guatemala	Nicaragua	Panama	Mexico
<i>Both sexes</i>												
10 and over	49.7	49.7	48.7	47.9	50.1	46.7	51.0	48.9	48.9	48.9	48.7	46.3
<i>Males</i>												
10 and over	84.5	84.8	84.4	85.1	78.6	82.9	80.2	80.3	81.2	82.3	76.1	77.0
10-14	37.8	37.4	39.9	40.0	17.4	—	20.0	20.0	25.0	25.0	10.0	—
15-19	88.9	91.1	90.6	89.6	68.3	—	84.0	84.0	87.0	86.0	66.0	—
20-24	95.6	96.7	96.6	96.9	94.8	—	92.9	94.2	94.4	94.8	93.4	—
25-34	97.1	98.4	97.8	98.4	97.8	—	94.3	95.9	95.5	96.3	96.3	—
35-44	97.5	98.6	97.9	98.7	98.2	—	94.7	96.1	95.7	96.5	96.7	—
45-54	97.5	97.6	97.3	98.5	97.1	—	94.7	95.1	95.1	96.3	95.6	—
55-64	95.4	94.8	94.7	97.3	89.6	—	92.7	92.4	92.7	95.1	98.3	—
65 and over	82.7	74.0	74.1	86.3	70.3	—	75.1	70.3	74.0	80.0	63.0	—
<i>Females</i>												
10 and over	16.2	15.2	12.5	13.0	20.3	12.5	21.9	17.6	15.7	15.7	20.9	16.0
10-14	7.9	5.0	6.4	6.4	5.3	—	8.0	3.5	7.0	7.0	4.0	—
15-19	20.7	22.5	15.8	15.0	23.4	—	29.1	27.3	19.9	18.5	24.8	—
20-24	20.9	22.6	14.9	16.3	29.6	—	29.4	27.4	18.8	19.7	31.3	—
25-34	17.4	17.2	13.0	14.5	25.2	—	24.5	20.8	16.4	17.5	26.7	—
35-44	17.3	15.7	13.9	14.3	24.6	—	24.4	19.0	17.5	17.2	26.1	—
45-54	15.9	13.3	13.5	13.7	20.8	—	22.4	16.1	17.1	16.5	22.0	—
55-64	13.5	9.1	12.3	13.1	15.0	—	19.0	11.0	15.6	15.8	15.9	—
65 and over	10.6	5.6	8.9	8.9	8.4	—	11.8	6.8	11.9	10.7	8.6	—

SOURCE: *Human Resources of Central America, Panama and Mexico, 1950-1980, in relation to some Aspects of Economic Development* (United Nations publication, Sales No.: 60.XII.1), tables XXV, XXVI, XXVII, XXVIII, XXIX and XXX, pp. 138-140.

might be offset by increased school enrolment among girls aged 10-12. For males aged 65 and over, the activity rates resulting from the first approximation were slightly decreased to allow for a greater frequency of retirement as general standards of living rise, mainly as a result of accelerated economic development and the gradual expansion of social security schemes. For women aged 65 and over, it appeared reasonable to make a slight downward adjustment in some cases, whereas in others the first approximation results were left unadjusted.

Even in the case of adult males, methods of projection by direct extrapolation, for example, may yield absurd results. Annexes I and II show that in the case of Japan, for instance, the application of these methods gives, for the 30-34 age group, an activity rate of 99.8 or 100 per cent in 1980, depending on whether equation (a) or equation (b) is used for the corrective coefficient. In every country there will always be a small percentage of adult males who are incapable of working for health and other reasons. Every result arrived at by mechanical projection must therefore be submitted to careful scrutiny.

Activity rates derived by correlation and regression analyses should not always be taken as strictly reliable; they must be subjected to certain adjustments based on anticipated economic and social development and its effects on the labour force. Some judgements on trends in activity rates may be better than the mechanical results of a mathematical operation which takes into account only some of the many factors involved.¹⁸ This applies particularly to the determination of the activity rates of economically active females in the youngest and oldest age groups. In such cases, in view of the uncertainties inherent in such judgements, it seems essential to formulate several assumptions concerning changes in the rates, allowing for such factors as prospects for increased school enrolment or pension schemes.

E. MEASURING THE RELATIVE INCIDENCE OF POPULATION GROWTH, CHANGES IN ACTIVITY RATES AND OTHER VARIABLES ON THE FUTURE SIZE OF THE ECONOMICALLY ACTIVE POPULATION

A projection of the size of the economically active population, broken down by sex and age, is obtained by multiplying the number of persons in the projected population by the projected activity rates. The relative incidence of population growth and of changes in activity rates on the future size and sex-age structure of the economically active population must then be determined. Table 20 shows patterns of change in the total economically active population, by sex and by age, of the United States of America from 1965 to 1980

arising from population growth, on one hand, and changes in activity rates, on the other.

What strikes one first of all is that nearly 88 per cent of the total increase in the male economically active population and about 72 per cent of the increase in the female economically active population are attributed to population growth. In the case of males 65 years and over, the sharp projected decline in activity rates will be almost entirely offset by the increase in the numbers of the group. Changes in activity rates are much more marked in the female economically active population, especially in the age groups in the 35-64 year range. The effect of these two factors may be analysed in greater detail in order to ascertain, for instance, their proportionate contribution to changes in the activity rates of the economically active population as a whole. A simple method is utilized for this purpose. The total activity rate is taken to be:

$$a_{\Sigma} = \frac{A_{\Sigma}}{P_{\Sigma}} = \frac{A_m + A_f}{P_{\Sigma}} \\ = \frac{A_m}{P_m} \cdot \frac{P_m}{P_{\Sigma}} + \frac{A_f}{P_f} \cdot \frac{P_f}{P_{\Sigma}} = a_m p_m + a_f p_f$$

This equation is used, in conjunction with the data in table 20, to derive the following changes in the total activity rate from the incidence of the activity rates of the male and female economically active populations and the proportion of total population they represent:

	Symbol	(t) 1965	(t ₁) 1980
Economically active population (14 years and over)			
TOTAL . . .	A_{Σ}	78.357	101.408
Male	A_m	51.705	65.981
Female	A_f	26.653	36.427
Population (14 years and over)			
TOTAL . . .	P_{Σ}	138.261	173.908
Male	P_m	67.205	84.123
Female	P_f	71.056	89.785
Activity rates			
TOTAL . . .	a_{Σ}	56.7	58.3
Male	a_m	76.9	77.2
Female	a_f	37.5	40.6
Proportion of total population			
Male	$p_m = \frac{P_m}{P_{\Sigma}}$	48.6	48.4
Female	$p_f = \frac{P_f}{P_{\Sigma}}$	51.4	51.6

The data in table 20 are also used in the following procedure:

Change in the male activity rate:

$$p_{m_{t_1}} (a_{m_{t_1}} - a_{m_t}), \text{ or } 48.4 (77.2 - 76.9) = 0.145;$$

Change in the female activity rate:

$$p_{f_{t_1}} (a_{f_{t_1}} - a_{f_t}) \text{ or } 51.6 (40.6 - 37.5) = 1.599;$$

¹⁸ S. Cooper and D. F. Johnston, "Comments on the Denberg-Strand-Dukler approach", *Industrial Relations*, vol. 5, No. 1, October 1966, p. 73.

TABLE 20

United States of America: changes in the total economically active population, by sex and age, arising from population growth and changes in activity rates, 1965 and 1980

Sex and age groups (1)	Total economically active population (thousands)			Changes in total economically active population				Relative incidence of changes (per cent)	
	1965 (observed)	(1980) (projected)	1980 * (projected)	Total	Due to population growth	Due to changes in activity rates	Totals	In activity rates	In population numbers
	(2)	(3)	(4)	(5) = (3) — (2)	(6) = (4) — (2)	(7) = (3) — (4)	(8) = (3) : (2)	(9) = (3) : (4)	(10) = (8) — (9)
Both sexes									
14 years and over	78,357	101,408	98,606	23,051	20,249	2,802	29.4	2.8	26.6
Males									
14 years and over	51,705	64,981	64,691	13,276	12,986	290	25.7	0.4	25.3
14-19	4,591	5,744	5,610	1,153	1,019	134	25.1	2.4	22.7
20-24	5,926	9,065	8,960	3,139	3,034	105	53.0	1.2	51.8
25-34	10,653	17,590	17,554	6,937	6,901	36	65.1	0.2	64.9
35-44	11,504	12,084	12,021	580	517	63	5.0	0.5	4.5
45-54	10,131	10,219	10,144	88	13	75	0.9	0.7	0.2
55-64	6,768	8,185	8,134	1,417	1,366	51	20.9	0.6	20.3
65 years and over	2,131	2,096	2,584	-35	453	-488	-1.6	-18.9	17.3
Females									
14 years and over	26,653	36,427	33,669	9,774	7,016	2,758	36.7	8.2	28.5
14-19	2,940	3,832	3,571	892	631	261	30.3	7.3	23.0
20-24	3,375	5,380	5,084	2,005	1,709	296	59.4	5.8	53.6
25-34	4,336	7,347	7,019	3,011	2,683	328	69.4	4.7	64.7
35-44	5,724	6,386	5,862	662	138	524	11.6	8.9	2.7
45-54	5,714	6,805	5,787	1,091	73	1,018	19.1	17.6	1.5
55-64	3,587	5,337	4,579	1,750	992	758	48.8	16.6	32.2
65 years and over	976	1,340	1,281	364	305	59	37.3	4.6	32.7

SOURCE: United States of America, Bureau of Labor Statistics, Special Labor Force Report No. 73, *Monthly Labour Review*, September 1966, p. 986.

* Economically active population in 1980 calculated on the basis of 1965 activity rates. As the figures given have been rounded off to the nearest whole number, the sum of the figures in the individual groups may not be equal to the totals given.

Share of the male population:

$$(a_{m_t} p_{m_{t_1}} + a_{f_t} p_{f_t}) - (a_{m_t} p_{m_t} + a_{f_t} p_{f_t}), \text{ or } (76.9 \times 48.4 + 37.5 \times 51.4) - (76.9 \times 48.6 + 37.5 \times 51.4) = -0.154;$$

Share of the female population:

$$(a_{m_t} p_{m_t} + a_{f_t} p_{f_{t_1}}) - (a_{m_t} p_{m_t} + a_{f_t} p_{f_t}), \text{ or } (76.9 \times 48.6 + 37.5 \times 51.6) - (76.9 \times 48.6 + 37.5 \times 51.4) = 0.075.$$

The absolute increase in the activity rate of the total economically active population in 1965-1980 is approximately 1.6 per cent; the analysis above shows that it is the product of the following changes:

	Absolute change	Relative change
(1) Increase in male activity rates	0.145	8.70
(2) Increase in female activity rates	1.599	96.04
(3) Decrease in the proportion of males in the total population	-0.154	-9.24
(4) Increase in the proportion of females in the total population	0.075	4.50
Total (1), (2) and (4)	1.819	109.24
Total (3)	-0.154	-9.24
Total (1), (2), (3) and (4)	1.665	100.00
Remainder	0.065	3.91

This procedure demonstrates that the increase resulting from higher female activity rates is approximately equal to the increase in the activity rates of the total economically active population. The changes in other components are minimal.

The method described above may also be utilized for projecting female activity rates by marital status. As a rule, however, there is no theoretical single measure of the separate incidence of each relevant factor on the economically active population. Changes in each factor considered occur simultaneously, so that the effect of one change is necessarily influenced by other changes.¹⁹

¹⁹ In addition to the method described here, reference may be made to the method used to project the economically active population of the United Kingdom of Great Britain and Northern Ireland, especially its female segment. See W. Beckerman and J. Sutherland, "Married women at work in 1972", *National Institute Economic Review*, No. 23, February 1963, pp. 59-60. See also W. Beckerman and associates, *The British Economy in 1975* (Cambridge University Press, 1965), chap. III.

Chapter III

OTHER ASSOCIATED ESTIMATES

Sex-age-specific labour force projections provide information on the size and structure of the total future labour supply. The economically active population, like the total population, is subject to a continual replacement movement. It is therefore essential to estimate the flows of entries into and separations from the economically active population during the projection period, i.e. to determine the number of new entrants into the active population and the number of separations from it because of death, retirement or other causes. New entrants into the economically active population increase its size, whereas separations from active life decrease it. Factors on which these two components of the labour replacement movement depend include activity rates on a specified date, age-specific mortality, migration¹ and a long-term assessment of fertility trends.

These associated estimates are essential in forming labour policy, because they make it possible to determine the number of workers who must be recruited in future years if full employment is to be attained; this number is, in fact, equivalent to the total number of entries into the economically active population during the period in question, whereas the difference between the economically active population in the base year and the estimated numbers of that population in the final year of the projection yields only an estimate of the net increase, after allowance is made for losses by death, retirement and withdrawals from working life. The latter procedure therefore yields an arithmetical remainder and gives no indication of the number of new entrants to the labour market. Calculating the number of new entrants into the economically active population and the number of persons who will have to be replaced raises difficult problems of principle. In the first paragraph of the following section the concept of labour supply replacement will be defined. Thereafter methods of estimating replacement movements will be examined. Finally, two methods of calculating the length of working life for future years will be described; these methods provide valuable information on future trends in the labour supply.

¹ In cases where economically active persons withdraw from the labour force by migration, the meaning of the term "retirement", which is generally applied to persons who cease to participate in productive economic life, must be extended to include migrants.

A. LABOUR SUPPLY REPLACEMENT

Analysis of the entries into and separations from the economically active population reveals not only the magnitude of these movements but also the characteristics which differentiate those entering the labour market from those withdrawing from it. A projection of the future characteristics of labour supply replacement may be derived from projections of the active population by sex and by age. Making such a projection is a very complex process. Available statistical data are confined, in practice, to the distribution by sex and, most frequently, by five-year age groups, of the labour supply in the base year and the final year of the projection period. If there is a five-year interval between these two years, life tables may be applied to the totals in each age group (25-29 years, for example) for the following five years in order to calculate the number of survivors in the final year. The total of these survivors is then treated as the 30-34 age group. The difference between this figure and the number of persons predicted for the final year by the projection represents the number of entrants into working life during the period in question from among persons aged 25-29 during the base year.

Such calculations, in reality, measure only crude differences. If, for example, workers in this age group are assumed to leave the labour force during the five-year period because of serious illness, the figure yielded by a calculation procedure to be outlined later in this chapter will represent the difference between the number of men in the 25-29 age group who will enter working life after the base year and the number of men in the same age group who, although active during the base year, leave the economically active population because of illness. In this case, the true number of entrants is greater than the number yielded by the calculation described above. This is only a slight drawback in the case just mentioned, since in this age group there are few separations from the male economically active population. The same is not true in the case of women, many of whom marry or bear children and leave the labour force. Other young women, however, complete their studies and enter working life between the ages of 25 and 29. The absolute figure yielded by the method described earlier is, in fact, the arithmetical difference between two statistically unknown quantities and not a figure for the exact number of entrants into working life in each age group.

The reliability of estimates therefore varies greatly

according to sex. For men, the following assumptions, which only slightly simplify the actual situations, may be made:

(a) All entries into the economically active population occur before the age at which activity rates attain their maximum value, i.e., generally between ages 30 and 35;

(b) There are no separations from the economically active population before this age for reasons other than death, i.e., no survivors retire at an age at which new entrants are still being recruited;

(c) There is only one entry and one separation per worker, i.e. no entry is followed by a separation and subsequent re-entry;

(d) Age-specific mortality rates are the same for active and inactive persons.

When replacement indices are based on these not unduly simplified assumptions, their significance may be somewhat limited in many cases. However, in countries in which suitable statistical data are not available, these assumptions allow the future evolution of the economically active population to be analysed in some detail. Naturally, where sufficiently reliable detailed statistics are available, the more elaborate technique of establishing working life tables can be applied.

Analysis of entries into and separations from the economically active population is largely limited, in practice, to the male population. Replacement movement in the female population is much more complicated because of the changes which occur in women's marital and family status. It is well known that marriage and the presence of children are the factors which most often tend to keep women out of the labour force or cause them to leave it, and that the proportion of such women who seek employment when their children reach school age and family responsibilities no longer keep them at home is sometimes substantial. This tendency to join and rejoin the economically active population at later ages (than males) is naturally more marked in the case of widows and divorced women, because of their greater need to provide for themselves and their children. Adequate data on changes in the female active population are not always available, even in many developed countries. Consequently, while it may be reasonable to accept the assumptions listed earlier in the case of males, they will probably not be valid for females.² The analysis may, however, if used with caution, give some idea of the future pattern of labour supply replacement in the female economically active population. The calculations yield an estimate of the real number of women who will enter or return to working life, but one which is necessarily somewhat unreal, because the entries and separations are being compared within individual age groups.

B. CALCULATION OF THE REPLACEMENT INDICES OF THE ECONOMICALLY ACTIVE POPULATION

The components of the labour replacement movement are: the number of entries into the economically active population; the number of separations from it; and the net increase — or decrease — in the economically active population. The difference between the economically active population at the beginning and that at the end of each projection period (the usual period being five or ten years) is established by cohort. The procedure is as follows:

(a) Entries into the economically active population comprise persons who reach the usual age of entry to the labour market and who obtain or seek employment during the period considered. For example, the number of new entrants between the ages of 15 and 19 in 1971 comprises persons who are in the age group 10-14 in 1966 and who, according to the projection, will be survivors in 1971 and will obtain or seek work;

(b) Separations from the economically active population comprise persons who leave working life through death or retirement;

(c) the net change — increase or decrease — in the economically active population is the difference between the number of new entrants and the number of withdrawals, either for the whole population³ or for a specified sex-age group. It may show what new employment opportunities must be created. In other words, total labour supply should be offset by total demand, if full employment is to be achieved.

Table 21 shows the working out of these components for each male cohort and for the total male economically active population of Thailand, as projected for the period 1966-1971. The assumption that entries into the economically active population occur before the age of 30, 35 or 40 is a simplification which ignores the fact that there are some separations at earlier ages than these through death or disabilities which prevent further employment. Accordingly, the new entries in table 21 represent the net increase, calculated by the subtraction $A_t^b - A_t^a$, in which A_t^a is the economically active population in age group a at the beginning t of the period and A_t^b the economically active population in the following age group b at the end t_1 of the period, the number of entries being calculated by the following formula $A_t^b - A_t^a \times s$, in which s is the survival ratio between the dates t and t_1 ; this ratio allows for the fact that some of the deaths were of persons who were among the economically active population at opening of the projection period, whereas others were of persons who entered that population during the period. The actual number of entrants during any period is always greater than the net increase.

² In fact, the pattern of female participation in the labour force just discussed makes it clear that the first three assumptions are unrealistic for the female component of the labour force.

³ Naturally, the net change in the economically active population may also be obtained by simply comparing the total numbers of the economically active population at the beginning and end of the period in question.

It is also useful to know the potential number of entrants into the economically active population, that is, the number of projected survivors for the period t, t_1 who are not economically active. The following formula is used:

$$(p_t^a \times s) - (A_t^a \times s) = (p_t^a - A_t^a)s = p_t^a s (1 - a_t^a)$$

in which p_t^a is the population of age a in period t , and a_t^a is the activity rate of the economically active population of age a in period t . The assumption here is that mortality is the same for the active and inactive populations. The remainder $p_t^a s (1 - a_t^a)$ shows the maximum number of potential additional entries into the economically active population during the projection period in question, if, that is, all persons surviving until the end of the period were economically active.

Separations from the economically active population through death may be calculated by the formula $A_t^a - A_t^a \times s$, which may be rewritten in the form $p_t^a a_t^a (1 - s)$. Here again, it is assumed in this formula that mortality is the same for the active and inactive populations. Separations from the economically active population through retirement or disability, occurring towards middle age or later, are calculated in the same manner as entries, subject to the assumption that a_t^b must be less than a_t^a .

In addition to these three indicators, the replacement ratio and the replacement rate are frequently estimated:

(a) The replacement ratio is the projected number of entries into the economically active population — as a whole or for a specific age group — during the projection period for every 100 separations through retirement or death. This ratio may be considered as indicating either: the pressure of labour supply, represented by the proportion of new entrants to the number of posts left vacant as a result of retirement or death, on labour demand, represented by the existing situation in the

labour market, or the pressure of the labour demand on labour supply, if the number of jobs exceeds the labour supply;

(b) The replacement rate expresses the net increase or decrease in economically active population — as a whole or at a specified age — as a percentage of the total economically active population at the beginning of the period considered, i.e., entries minus separations. This measure is similar in function to the rate of natural population increase — or decline — and may therefore be treated as an indicator of the probable growth of the economically active population. A clear distinction must be made between the number of new entrants and the growth of the economically active population: the former has an extremely important bearing on programmes of employment and vocational training.

The formulas for the replacement ratio and the replacement rate are:

$$\text{Replacement ratio} = \frac{E}{D} \times 100$$

$$\text{Replacement rate} = \frac{E - D}{A_t} \times 100$$

in which E is the number of entries, D the number of separations (through death, retirement or disability) and A_t the total economically active population at the beginning of the period considered. Table 22 provides an example of these labour supply replacement indicators. The source of statistical data used is once again the projection of the male economically active population of Thailand for 1966-1971.

It will be noted that these figures provide a more detailed picture of labour supply replacement than those in table 21: (a) firstly, the number of actual entrants into the economically active population, which is always greater than the number of new entrants (net increase),

TABLE 21
Thailand: projections of new entries and separations for the male economically active population, prepared in 1967

Age group	Male economically active population (thousands)		New entries (thousands)		Separations (thousands)	
	1966	1971	1966	1971	1966	1971
15-19	1,092.7	1,329.2	1,329.2	—	—	—
20-24	1,159.5	1,357.3	246.6	—	—	—
25-29	1,125.7	1,262.4	102.9	—	—	—
30-34	1,030.5	1,125.1	—	0.6	—	—
35-39	854.7	1,001.8	—	28.7	—	—
40-44	689.7	809.2	—	45.5	—	—
45-49	553.5	642.9	—	46.8	—	—
50-54	447.4	492.3	—	61.2	—	—
55-59	345.9	386.5	—	60.9	—	—
60 years and over	502.2	592.1	—	256.0	—	—
TOTAL	7,801.8	8,998.8	1,696.7	499.7	—	—
Increase in the economically active population		+1,197.0		+1,197.0		

SOURCE: Thailand, National Economic Development Board, *Fact book on manpower in Thailand* (Bangkok, 1967).

TABLE 22
Thailand: projections of replacement indices for the male population, 1966-1967

Age group (1)	Net increase due to new entrants (2)	Net decline (3)	Separations due to:			Potential entrants (7)	Actual entrants (8) = (2) + (6)	Unused labour supply (9) = (7) - (8)	Replacement	
			Death (4)	Retirement (5)	Total (6)				Ratio (10)	Rate (11)
15-19 ^a	491.3	—	10.7	—	10.7	1,217.2	502.0	715.2	—	58.6
20-24	264.6	—	13.1	—	13.1	532.7	277.7	254.0	—	24.2
25-29	102.9	—	15.3	—	15.3	198.7	118.2	80.5	—	8.9
30-34	—	0.6	18.1	—	18.1	58.3	17.5	40.2	—	0.005
35-39	—	28.7	21.4	7.3	28.7	33.2	—	4.5	—	2.8
40-49	—	470.4	298.6	171.8	470.4	539.0	—	68.6	—	13.9
50-59										
60 and over	—	—	—	—	—	—	—	—	—	—
TOTAL	858.8	499.7	377.2	179.1	556.3	—	915.4	1,163.0	171.9	4.2

^a Figures based on estimates for male population of age 10-14 years in 1966: numbers estimated at 2,069.1 and activity rate at 40.5.

s shown separately; (b) secondly, in the case of the central age group (30-34), separations due to death exceed the actual number of entrants, so that not only is the supply replacement entirely neutralized, but there is also a reduction in the total labour force; (c) thirdly, it is possible to determine what proportions of all separations from the economically active population are due to mortality and retirement respectively.

Table 22 provides further data, such as the potential number of entrants and the unused labour supply. These data help to give a more comprehensive picture of labour supply, particularly as regards its age structure, and are useful in any consideration of the utilization of over-all labour supply, especially in the case of an economy experiencing a labour shortage.

C. LENGTH OF WORKING LIFE

Another valuable measure for improving the data on the dynamics of the labour force is the length of working life, as determined by the level and duration of labour

force participation and by mortality. Two indicators often used in this connexion are gross years of working life, which depends only on the level of economic activity, and net years of working life, which also takes into account losses due to mortality.⁴ The advantage of these two measures is that they require only a fairly simple manipulation of data from projections of population and of activity rates as illustrated in table 23.

For the computation of the gross years of working life, the age limits of the working life span are set somewhat arbitrarily, usually at fifteen and sixty-five years.⁵ The age interval of fifty or sixty years represents

⁴ *Demographic Aspects of Manpower: Report I: Sex and Age Patterns of Participation in Economic Activities*, 1962 (United Nations publication, Sales No.: 61.XIII.4), p. 17.

⁵ Because of the lack of objective criteria for adjusting the activity rates of marginal groups, the preferred practice is to compute the gross years of working life between the ages of fifteen and sixty-five. Sometimes the upper age limit selected is seventy years and in the case of most developing countries it may be raised to seventy-five years.

TABLE 23
Thailand: gross years of working life ^a for male economically active population, 1966 and 1971

Age group	Age group interval (years)	Age-specific activity rate		Gross years of working life in each age group		Total gross years of working life	
		1966	1971	1966	1971	1966	1971
(1)	(2)	(3)		(4) = (2) × (3) : 100		(5)	
15-19	5	67.0	65.0	3.350	3.250	50.745	49.645
20-24	5	85.2	84.2	4.260	4.210	47.395	46.395
25-29	5	95.0	94.0	4.750	4.700	43.135	42.185
30-34	5	97.5	96.5	4.875	4.825	38.385	37.485
35-39	5	97.8	96.8	4.890	4.840	33.510	32.660
40-49	10	96.6	94.6	9.660	9.460	28.620	27.820
50-59	10	91.5	88.5	9.150	8.850	18.960	18.360
60-74 ^a	15	65.4	63.4	9.810	9.510	9.810	9.510

^a Male working ages limited to ages 15-74.

the probable working life span. The number of years during which an individual is economically active is determined very largely by his labour force participation rate, or activity rate the impact of which on working life is expressed by gross years of working life. If, for instance, the activity rate for the age group 25-29 is 95 per cent, an average individual is assumed to spend 95 per cent of that part of his life span, or 4.75 years, in working life (see table 23). The sum of the products of the activity rates and the age interval (in years) for a given age interval gives the total gross years of working life. For the male economically active population of Thailand, that total was approximately 50.7 years in 1966 while, because of an anticipated decline in activity rates for all age groups, the total for 1971, based on the projected activity rates for that year, is estimated at 49.6. Gross years of working life may also be computed for one segment of the working life span. For instance, the total years of working life up to the age of fifty was 31.8 in 1966 and the projections forecast a decline in that total to 31.3 in 1971.

In addition to gross years of active life, gross years of non-working life may also be estimated. This measure represents the difference between probable gross years and actual gross years of working life. For example, total years of non-working life for males up to the age of fifty was 3.2 years (35-31.8) ⁶ in 1966 and that figure is expected to rise to 3.7 years by 1971. These measures show the average gross years which a Thai male would spend in and out of working life if no allowance were made for mortality before the age of seventy-five and if the projected activity rates were assumed to be the true rates.

The measure of average net years of working life, unlike that of gross years of working life, takes into account both the level of economic activity and the mortality rate; it therefore represents the number of working years for a generation including persons whose working life is curtailed by death before they reach retirement age.⁷ The method of computing average net years of working life is shown in table 24, in which the meaning of the symbols is:

(a) The number of survivors at exact age l_x is derived from the life table and shows the number of men and women in a birth cohort of 100,000 who can expect to survive to exact ages fifteen, twenty, twenty-five, etc., given the mortality rates applicable to different ages;

(b) The stationary population between ages x and $x + n$, i.e. ($n^L x$) is the stationary population which may be treated as being the survivors in the age group x to $x + n$ (n being the age group interval);⁸

⁶ The probable working life of a person of fifty or under, assuming that he enters the economically active population at the age of fifteen, is thirty-five years.

⁷ The difference between gross and net years of working life may be explained by a reasoning similar to that used in defining the difference between gross and net reproduction rates as measures of fertility and population replacement.

⁸ When this function is not included in life tables, the formula $n^L x = (l_x + l_{x+n}) \times n/2$ may be used.

(c) Average net years of working life remaining at exact age x , i.e. ($e^o w_x$),⁹ have been calculated here as average years of working life remaining to the population as a whole.

Since the model life table chosen for 1966 shows 78,672 survivors at age 25 and the anticipated number of survivors at that age in 1971 is 81,409, average net years of working life for Thai males survivors at age 25 are 23.6 and 23.5 years respectively. Average net years of working life for survivors at age 60 are 2.5, in both 1966 and 1971 (see table 24).

Comparison of gross and net years of working life establishes probable losses from the economically active population due to mortality (see table 25).

Losses from the male labour supply in Thailand are obviously substantial at present; the same situation is expected to obtain in the early 1970s. Should the overall labour supply fail to satisfy over-all labour demand, appropriate action would probably centre on improving general health and social conditions, which are the main determinants of mortality in most developing countries. When, on the other hand, labour demand is inadequate — i.e. smaller than the over-all labour supply or the level of supply that is tolerated in circumstances of full employment — the total waste of labour resources, as illustrated by the situation recorded in table 25, is even greater than the proportion of inactive persons within the population as a whole.

Analysis of these indicators also makes it possible to gauge the respective effects of activity rates and mortality on economically active life. That may be done by assuming that activity or mortality rates remain constant throughout the projection period; thus, table 26 shows the difference between future net years of working life as determined by these two factors.

D. WORKING LIFE TABLES

Labour supply replacement, like length of working life, can also be studied by means of a working life table. The data on working life given in the table are based on observations made at a specific time. They therefore show conditions which will apply to any generation, if the mortality level and the activity rates do not undergo significant changes, or if they undergo such changes as are characteristic of the mortality or activity rates which are assumed to be likely to prevail in coming years. Working life tables help to make the assessment of future trends more accurate and are therefore very useful in the construction of assumptions

⁹ In working life tables, average expectancy of working life ($e^o w_x$) is defined as the average years of working life remaining to members of the economically active population at a given age, while net years of working life is the ratio between remaining years of working life for the economically active population and remaining years for the population as a whole. Since the numerator is the same in both cases, it follows that the value of net years of working life will always be smaller than the average expectancy of working life, the ratio between the two measures being $l_{wx} : l_x$, i.e. the activity rate.

concerning trends in the economically active population and changes in the demographic structure of the labour force, particularly with regard to sex-specific marginal age groups, which are the most unstable. This technique, when it can be applied to projections, may replace the labour supply replacement devices described earlier and the measures involving length of working life. Data on labour replacement provided by the table of working life is, in fact, more reliable than similar data obtained by the method of simply comparing successive cohorts described earlier.

The methodology of working life tables is discussed in great detail in a number of manuals and other documents which provide examples from various countries.¹⁰

¹⁰ See for example: United States of America, Bureau of Labor Statistics, *Tables of Working Life*, Bulletin No. 1001 (Washington, August 1950); Japan, Institute of Population Problems, *Abridged Working-Life Tables of Japanese Males, 1930, 1950 and 1955* (Tokyo, 1960); United Kingdom, Ministry of Labour and National Service, *The Length of Working Life of Males in Great Britain*, (London, 1959); United States of America, Bureau of Labor Statistics, *Changing Patterns of Working Life*, prepared by S. L. Wolfbein (Washington, August 1963); S. L. Wolfbein, "The length of working life", *Population Studies* No. 3, vol. III, December 1949, pp. 286-294; S. Garfinkle, "The lengthening of working life and its implications", *World Population Conference, 1965, Vol. IV: Migration, Urbanization, Economic Development* (United Nations Publication, Sales No.: 66.XIII.8).

It is perhaps sufficient here to list only the main functions in the tables. These are:

- (a) For each age interval
 - (i) The number living per 100,000 population born alive, that is, the number of survivors at age x from 100,000 live births;
 - (ii) The number living, per 100,000 born alive, who form part of the economically active population, that is, the percentage of the economically active population multiplied by the number of survivors at age x per 100,000 live births;
- (b) Between consecutive age intervals
 - (i) Entries into the economically active population (number, rate per 1,000 of total population or economically active population);
 - (ii) Separations from the economically active population (number, rate per 1,000 of economically active population):
 - due to all causes;
 - through death;
 - through retirement;
 - (iii) Net increase (+) or decrease (-);
- (c) At the beginning of each age interval
 - (i) Average number of years of working life remaining — expectation of working life at

TABLE 24
Thailand: net years of working life for males, 1966 and 1971

Ages ^a (x and $x + n$)	Survivors at exact age l_x	Survivors between ages x and $x + n$ ($n l_x$)	Activity rate between ages x and $x + n$ (per cent)	Years of working life of survivors between ages x and $x + n$	Total years of working life remaining at exact age x	Average net years of working life remaining at exact age x
(1)	(2)	(3)	(4)	(5) = (3) × (4)	(6) ^b	(7) = (6) : (2)
1966						
15	81,949	406,368	67.0	272,266	2,469,345	30.1
20	80,598	398,175	85.2	339,245	2,197,079	27.3
25	78,672	388,532	95.0	369,105	1,857,834	23.6
30	76,741	378,742	97.5	369,273	1,488,729	19.4
35	74,756	368,308	97.8	360,205	1,119,456	15.0
40	72,567	348,630	96.6	336,776	759,251	10.5
50	66,511	308,216	91.5	282,017	422,475	6.4
60	56,084	214,768	65.4	140,458	140,458	2.5
1971						
15	84,360	418,765	65.0	272,197	2,533,093	30.0
20	83,146	411,388	84.2	346,388	2,260,896	27.2
25	81,409	402,720	94.0	378,556	1,914,507	23.5
30	79,679	393,918	96.5	380,130	1,535,950	19.3
35	77,888	384,455	96.8	372,152	1,155,819	14.8
40	75,894	366,187	94.6	346,412	783,667	10.3
50	70,180	327,234	88.5	289,602	437,254	6.2
60	59,985	232,890	63.4	147,652	147,652	2.5

^a Life expectancy around 1960 is estimated at 52.5; on this point, see "An Evaluation of the Demographic Statistics of Thailand" (United Nations, Population Division, Working Paper No. 2, September 1966). For the purposes of this calculation, life expectancy has been assumed to be 55.0 in 1966, and 57.6 in 1971. The corresponding figures of survivors are taken from the United Nations model life tables.

^b The first figure in column (6) is obtained by adding together the figures in column (5) and the following figures, the figure in column (5) being subtracted from the figure in column (6) for the preceding age group.

age x, for economically active survivors or for all survivors of age x;

- (ii) Average number of years of non-working life remaining.

The basic assumptions used for estimation purposes are the same as those outlined at the beginning of this chapter. They may be adequate and are unlikely to introduce any significant error in so far as they relate to the economically active male population. The difficulties with regard to the female component have already been mentioned, as have the reservations which must be made, and the caution with which female activity rates must be treated. Nevertheless, since the economically active female population has come to constitute a larger proportion of the total economically active population, better and more accurate data on the characteristics of female working life are required. The numbers and structure of the economically active female population are, as a matter of course, affected by such demographic factors as marriage, fertility, widowhood and divorce. Marriage and the birth of

children are, in fact, the main reasons why women leave economically active life and why they must at certain ages remain outside the economically active population. When analysing the female economically active population account should be taken of certain economic and social conditions, in particular the possibility of expanding that population and the losses which may result from the specific nature of female working life.

The female working life tables which have been constructed in some countries may provide a useful analytical framework for the study of individual aspects of the female labour force, in particular its replacement and the length of working life. An analysis of this type was attempted for the female economically active population of the United States of America in 1940 and 1950.¹¹ In order to determine which are the impor-

¹¹ United States of America, Bureau of Labor Statistics, *Tables of Working Life for Women, 1950*, prepared by S. H. Garfinkle, Bulletin No. 1204 (Washington, D.C., 1957).

TABLE 25

Thailand: comparison of gross and net years of working life of male economically active population, 1966 and 1971

Age	1966				1971			
	Gross	Net	Difference		Gross	Net	Difference	
			Years	Per cent ^a			Years	Per cent
15	50.7	30.1	20.6	40.6	49.6	30.0	19.6	39.5
20	47.4	27.3	20.1	42.4	46.4	27.2	19.2	41.4
25	43.1	23.6	19.5	45.2	42.2	23.5	18.7	44.3
30	38.4	19.4	19.0	49.5	37.5	19.3	18.2	48.5
35	33.5	15.0	18.5	55.2	32.7	14.8	17.9	54.7
40	28.6	10.5	18.1	63.3	27.8	10.3	17.5	62.9
50	19.0	6.4	12.6	66.3	18.4	6.2	12.2	66.3
60	9.8	2.5	7.3	74.5	9.5	2.5	7.0	73.7

^a Percentage of gross years of active life.

TABLE 26

Thailand: comparison of net years of active life and effect of changes in activity rates and mortality, male economically active population, 1966 and 1971

Age	Net years of active life			Total difference	Difference due to	
	1966	1971	1971 ^a		Activity rate	Mortality
(1)	(2)	(3)	(4)	(5) = (3) - (2)	(6) = (3) - (4)	(7) = (4) - (2)
15	30.1	30.0	30.6	-0.1	-0.6	0.5
20	27.3	27.2	27.6	-0.1	-0.4	0.3
25	23.6	23.5	23.9	-0.1	-0.4	0.3
30	19.4	19.3	19.6	-0.1	-0.3	0.2
35	15.0	14.8	15.2	-0.2	-0.4	0.2
40	10.5	10.3	10.6	-0.2	-0.3	0.1
50	6.4	6.2	6.4	-0.2	-0.2	—

^a Based on 1966 activity rates.

tant factors governing the female economically active population, the table includes:

(a) The stationary female population, by marital status and presence of children;

(b) The activity rate, by marital status and presence of children;

(c) The stationary female economically active population, by marital status and presence of children, including the following groups:

(i) All women;

(ii) Single women;

(iii) Wives, by presence or absence of husband:

All married women;

Married women, husband present;

Other marital status;

(iv) Married women, by number of children:

No children;

Children under five years;

Children five years and over;

(d) Estimated annual number of entries into and separations from the female economically active population, by selected demographic factors;

(e) Average number of years of working life remaining for all women and for single women.

The following are some of the features of replacement movement included:

(a) Accession to economically active life (entry and return), as influenced by:

Presence of children of school age;

Loss of husband;

Age;

(b) Separation through:

Marriage;

Birth of children;

Death;

Other causes.

For the construction of these tables, high-quality demographic statistics and activity statistics for the individual demographic variants must be available. Needless to say, such statistical material is not available in many countries. The data provided by working life tables are therefore valuable for computing estimates of female labour supply replacement, the length of female working life, and the size and structure of the female economically active population.

Part Two

METHODS OF PROJECTING LABOUR DEMAND

Chapter IV

GENERAL

Before projection methods are described, the concept of labour demand needs to be defined and the principal means of estimating it, statistically, outlined. The different types of projection which can be prepared must be distinguished: for example, is the purpose of the projection to assess labour requirements or the probable trend of employment? Are the projections to be short-term, medium-term or long-term? Thereafter the main projection methods which may be used will be described and their basic principles explained.

A DEFINITION OF THE CONCEPT OF LABOUR DEMAND AND MEANS OF MEASURING IT

The economically active population can be defined in a number of different ways. The concept of labour demand corresponds to one of them, that of the economically active civilian population in employment. At the theoretical level, this definition is clear, but quantification of the concept raises various practical obstacles to which attention must be drawn.

1. *The concept of labour demand: theoretical definition*

In Part One of this manual the economically active population was discussed from the standpoint of supply and therefore considered as consisting of all persons seeking to be employed. Labour demand is the number of jobs supplied by the economy at a given date. This number varies with production trends, increasing with economic expansion and declining with recession, so that changes in the size of the economically active population in employment are related to fluctuations in the economy.

There are two differences between the labour supply and the employed economically active population:

(a) All persons having no job but desiring to have one are included in the first of these definitions of the economically active population and excluded from the second. These persons may be unemployed workers who have lost their jobs and wish to find others — or persons seeking a job who have not worked recently but do not qualify as unemployed. Many women who form part of the labour supply are in this latter situation;

(b) Persons in military service, whether they are young people subject to conscription or persons making their career in the armed forces, are excluded from the employed economically active population but are

included in the labour supply. Labour demand covers only the demand for civilian labour.

2. *Means of measuring labour demand and practical difficulties in estimating it*

The concept of labour demand appears to be clear and easy to quantify, inasmuch as it is related to the availability of jobs. Measuring would therefore seem to require only a count of the number of jobs. Detailed analysis of this question shows, however, that there are a number of practical difficulties: not all jobs are full-time and some workers holding full-time jobs are in fact underemployed. Rather than counting the number of jobs available in an economy, it would be better to use a more rigorous definition involving the number of hours actually worked in a year.

(a) *Part-time workers*

One may be engaged in an occupation on one's own account or as the employee of another person, an enterprise or a public authority such as the State. Among the heads of enterprises and employees, the practice of a part-time occupation affects only a relatively small number of workers, largely women or elderly persons. Forms of occupation are not, however, confined to these two situations; there is a third, that of family helpers. In this case, the worker belongs to the family of the head of the enterprise in which he works and receives no salary. Usually it is the wife or children of the head of an agricultural, handicraft or commercial enterprise who are involved. Classification of such persons raises difficult problems: some of them can be assimilated to full-time employees, from whom they differ only in legal status. In many cases, however, the help these workers provide is very limited and perhaps intermittent: a farmer's wife, for example, may work for the greater part of the day on the farm, or provide a few hours' work a day or work only on certain days of the year — harvest time.

The definitions of occupation used in population censuses vary greatly from one country to another. Some countries prescribe a high number of hours of regular work each week before family helpers are regarded as genuinely in employment and thus being members of the economically active population. In other countries, the definition is much broader.

The way in which employment (or job) is defined therefore varies, even within a single country, since part-time workers are included in the same totals as those

who are working full-time throughout the year. Moreover, the definition varies from one country to another.

(b) *Underemployed workers*

The concept of underemployment is somewhat different from that of part-time work. The person may have a job which he thinks of as a full-time occupation and in fact be working only half-time. Such situations are particularly common in the agricultural and the services sectors. The Indian peasant who can work only at certain seasons is treated, in the statistics concerning economically active population, as being in full-time employment. No distinction is made between him and the factory worker who works for forty-five hours a week. Estimates of the economically active population in employment are thus essentially heterogeneous. The issue of underemployment may also arise in industry; if the working week in one branch is thirty-five hours at a given date, whereas the normal working week is over forty hours, workers in that branch might appear to be underemployed. However, this is more often than not only a temporary situation caused by economic fluctuations, whereas in agriculture and the services sector, the underemployment among some workers is chronic.

In the United States of America a definition of the concept of underemployment has been formulated which allows for all of these very different situations. The concept is a measure of the underemployment of workers over the whole year, and the underemployed, for this purpose, comprise workers not employed for fifteen weeks or more during the year and those whose income from a full-time job was less than \$3,000 in the same year. This new concept combines unemployment, underemployment in the traditional sense and insufficiently productive employment. However, its measurement requires a considerable amount of statistical data which are difficult to obtain, in particular on the total annual income of workers.¹

Estimates of the economically active population in employment are therefore heterogeneous, since they add together jobs in which the man-hours worked are not the same. In some countries where underemployment in agriculture is substantial, it may be assumed that almost half of the labour force is not employed full-time. For these reasons, it would be preferable to express labour demand at a given date as the total number of hours of work required to meet the needs of production. For practical reasons, however, this is not feasible. No country has the necessary detailed information on hours worked, and this is especially true of sectors in which part-time employment and underemployment are widespread. However, part-time employment and underemployment are factors which cannot be overlooked in making projections.

All estimates of the agricultural labour force must, in almost all countries, take underemployment into

account. The process must not, however, be carried too far; underemployment may be the product of climatic conditions whose effects cannot be entirely eliminated by technical progress. In such circumstances, projections cannot be confined to only those jobs which provide a full-time year-round occupation for agricultural workers.²

An example of this can be found in industry. One may take the case of an industrial branch in a highly developed country where working hours are exceptionally short. If a considerable increase in production in the sector involved is planned for coming years, the increase in the employed labour force will be smaller than that required if, during the base year used for the projection, working hours had been normal.

B. WAYS OF ASCERTAINING PAST TRENDS IN LABOUR DEMAND

Labour demand is measured by the economically active population in employment. There are two essential means of estimating it: the population census and surveys at enterprises. Brief accounts of these follow.

1. *Population censuses*

Periodic population censuses have one essential theoretical advantage: they are exhaustive. When they are taken, all the inhabitants of a country are included in the scope of the survey. Traditionally, questions are asked as to occupation: Is the respondent employed on the date of the survey? In which economic sector is he working? What is his trade? By suitable processing of the answers, the numbers of the population in employment and their distribution by economic sector and by occupation can be computed. Other information is usually gathered at the same time concerning the status of economically active persons (employers, employees, family helpers) and on educational level (certificates of general or vocational education held, number of years of study, age of leaving school or university). Cross-referencing of all this data enables a fairly complete picture of the characteristics of the employed economically active population to be built up: thus, the distribution by occupation of the labour force in a given sector of economic activity, say, the iron and steel or the electrical machinery industry, can be determined or its distribution by educational level established.

In countries which cannot carry out comprehensive population censuses, effective sampling techniques have been perfected in recent years which make it possible to secure the same data for a sample of the population regarded as representative.

The main drawback of population censuses is lack of clarity in the replies. A census is an inquiry made of

¹ United States of America, Bureau of Labor Statistics, *Manpower Report of the President of the United States* (Washington, D.C., 1968), p. 34.

² For a detailed discussion of this question see chapter V, section A, which deals with projection methods in agriculture.

persons who, in many cases, do not reply in the presence of the inquirer and for that reason the essential details are frequently lacking. This applies to statements as to occupation and, above all, as to educational levels. Tables based on incomplete replies are often difficult to interpret, since the number of headings created to record these replies is too large. This drawback exists in all countries, whatever their level of economic development.

2. Surveys at establishments

The surveys have advantages and drawbacks which are the reverse of those of population censuses:

(a) These surveys can yield precise information on the occupation of the workers employed. The establishment knows the exact occupations of its employees and classifies them in its records by that criterion; it can therefore reply easily to inquiries of this kind. Moreover, data can be obtained which cannot be collected through population censuses, such as data on the nature of the capital equipment and size of the establishment. This information is very useful in analysing the factors which determine the level of employment and its distribution by occupation in the various sectors of the economy;

(b) However, these surveys have a double drawback: they can scarcely ever be exhaustive and they presuppose the prior existence of a register of all establishments in the country. Experience shows that the task of setting up and, more important, keeping this register up to date is a difficult one and rarely perfectly performed, even in countries with a sound statistical infrastructure. Moreover, the fact that there are many small enterprises, each employing only a few people, in certain sectors of the economy makes it difficult to carry out the surveys. Finally, these surveys yield no data on the educational level of the workers employed. Establishments which know precisely what qualifications their employees have are very rare.

Thus, experience shows that recourse must be had to both these essential means of ascertaining facts on the economically active population in employment, in so far as they are complementary. An over-all picture of this population segment can be obtained only through a census or a sample survey of the population. Certain data which enable the links between employment and the factors of production to be analysed can be supplied only by establishments; this information is, however, limited to the population working in enterprises and does not cover workers who are in the subsistence or the tribal sectors, or in the armed forces.

C. MAIN TYPES OF LABOUR DEMAND PROJECTIONS

The projecting of trends in labour demand in future years can be approached in various ways. The different types of projection can be classified in relation to three criteria: (a) the purpose of the projection itself (is it to be a projection of theoretical manpower needs for implementing a plan, or of the most probable trends in

employment in the years to come?); (b) the mode of distribution of labour demand (is it sought to determine the future structure of this demand by status, by sector of economic activity, by occupation, or by level and type of education?); and (c) the length of the projection period (is the trend of employment to be estimated on a short-term, medium-term or long-term basis?). These types of projection are dealt with in detail below.

1. Projections differentiated according to their purpose

In a country which has defined its economic development targets in, for example, a plan, employment projections serve to determine the manpower required to achieve those targets. Their function is then normative and takes the form of estimating, say, the number of engineers or technical staff which industry must recruit in order to attain the desired level of industrial output, or the number of secondary and primary teaching posts which will have to be created in order to provide for compulsory school attendance by children up to the statutory leaving age. These estimates are an adjunct to economic planning, but an entirely subordinate one. The real feasibility of recruiting the workers needed is studied only at the second stage. Once the plan has been prepared and been transposed into manpower terms, the compatibility of the estimated manpower needs with the available capacity for training highly skilled personnel is reviewed. If this review leads to the conclusion that it is a practical impossibility to train the required skilled workers in present educational conditions, the necessary measures for the reform of education must be considered or, if it appears that even a thorough reform of the educational system will not make it possible to train the necessary personnel, the economic targets of the plan will have to be revised.

This type of projection is very different, both in purpose and in the projection methods employed, from an estimate of the probable future trend of employment. In the latter case, the evolution of production and the effect of productivity on the growth of employment, are also taken into consideration. Here, however, the basis of the projection is not the output target, but the expected evolution of production to meet the spontaneous evolution of demand. The normative function is absent. Moreover, and most important, the supply of skilled labour which will be available in the coming years is taken into consideration right from the beginning of the calculations. The probable trend of employment depends, of course, on the balancing of supply and demand, and accordingly the aim in this case is not to find out the number of engineers required, but the number actually available for recruitment, bearing in mind the needs of the economy and the number of engineers who will be on the labour market in future years.

Hence the difference in approach in these two types of projection is maintained up to the end of the calculation process: in the first type, the goal is to define a policy of education, employment and production; in the second, action is not the aim of the projection, which is simply an attempt to determine the structure of

future employment: it is merely a medium of information on the future.

There is, in theory, a third type of projection: an extrapolation. Labour demand in future years is estimated solely in relation to its development in the past. Thus it is assumed that in the future the same factors as in the past will govern the level of employment and its distribution by, for example, occupation, and that the proportionate impact of these factors will be the same. The result is a reference projection established for a specified future year. This projection is a theoretical one and there is no real prospect that it will prove to be accurate; it can, however, be used as a basis for analysing the causes of change, each of these causes being analysed separately and its effect on labour demand assessed.

These three types of projection must be clearly distinguished from one another. Experience shows that in a good deal of projection work on employment carried out throughout the world they are confused. In some cases the projected trend of employment is based on needs related to output targets; in others, in the absence of targets for a given sector, the probable trend is assessed or a projection of past trends is made, for want of anything better. Of course, such situations cannot always be avoided but it is important that they should be clearly identified.

2. Projections differentiated according to the mode of labour distribution

Four main criteria for classifying the employed economically active population may be distinguished: status, sector of economic activity, occupation and skill, and level and type of training. A labour demand projection can theoretically use any of these classifications, but the practical value of some of them is limited.

An employment projection by status is of no value at all. A distribution among heads of enterprise, family helpers, employees in the private sector and those in the public sector falls short of being a precise analysis of the future trend of employment, and the results cannot be used to define an employment or education policy. Moreover, the kinds of training required are, in some cases, the same, whether the workers are employees or heads of enterprises. This applies, for example, in the building trades — mason, plumber, electrician. No employment projection so far made seems to have used this criterion for the classification of the economically active population.³

There has, on the other hand, been a considerable amount of work on distribution by sector of economic activity. Such projections cannot easily be used to define employment policy, because a single sector of economic activity may employ workers of very different occupations. In the textile industry, for example, there are engineers and skilled textile workers, but also electricians, mechanics, and clerical workers. The value

of a knowledge of the future distribution of the economically active occupation by sector in determining requirements by occupation varies greatly. However, even if it proves to be insufficient, this projection method is an essential stage in a more complex operation, for two reasons: firstly, projecting methods differ greatly depending on the major economic sector considered — future employment in agriculture cannot be estimated in the same way as employment in industry or in the services sector. A distinction has to be made at the start, at least among these three sectors. A comparison of labour demand and supply by major sector in the initial stage may well show a significant distortion as between the employment needs of the population and the manpower needs of the economy. This will demonstrate the inadequate growth of certain sectors of the economy, and a new plan, more ambitious with regard to the growth prospects of the economy, will have to be established. Secondly, it is frequently necessary to obtain an estimate of the total level of employment in a given branch of the economy before a distribution of the population by occupation or level of skill is available.

The most useful distribution of the economically active population for employment policy purposes is that by occupation or level of skill. Most recent employment projections are based on this criterion.

The number of distinct occupations or levels of skill allowed for varies greatly from country to country: some have adopted a very long list of occupations — over 100 and in some instances 200; others allow only for the ten major occupational groups of the standard classification of the International Labour Office. Where there is a classification by levels of skill, the major occupational groups are cross-referenced with the levels of skill, if they cover more than one level, as is usually the case with production-process workers. As projection methods are different depending on the degree of precision desired, a choice has to be made at the outset.⁴

The distribution of labour demand which is most useful for the purpose of educational policy is that by level and type of training. These terms have been defined earlier. Unfortunately, it is particularly difficult to prepare projections on the basis of that criterion. The manpower requirements of a given sector of the economy cannot be projected directly from such a break-down. These needs, in so far as they can be analysed, are related to occupations: engineers, clerical workers, electricians. In certain cases, these occupations do correspond to specific levels or types of training, but this is not always the case. Many occupations can be practised by persons having widely varying levels and types of training. This applies to all clerical jobs, whatever their rank — chief of personnel or skilled clerk. Usually the necessary transposition has to be made at a later stage, by means of a cross-tabulation

³ Forecasts by status may nevertheless be useful for sociological research on the situation of the forms of organization of a society.

⁴ This subject will be considered in detail in chapter V (sections B and C), in which projection methods in the construction and services industries are reviewed.

in which specific levels and types of training are equated with occupations.⁵

3. Differentiation by length of the projection period

The length of the projection period strongly influences the choice of methods. There are three types of projection to be considered.

A one-year projection is of use only for employment policy: education policy requires much longer-term projections, because the effect of any measures taken is not felt until some years later, when those having the new qualifications leave schools and universities. Short-term projections may be useful for fixing a rate of increase for output for a single coming year which will be compatible with the maintenance of full employment, or for determining the broad outline of the recruitment policy which the public manpower authorities will have to adopt in order to meet the immediate needs of the economy quickly.

Five-year or seven-year projections are made, more often than not, as part of national economic planning. The period of implementation for most plans falls somewhere between the two. Hence the analysis of the future evolution of employment can be fairly accurate, since a considerable amount of documentation on trends in the factors which govern the level of employment is available. In this case the projection period is probably not as long as the period needed for the implementation of an education policy; it is, however, sufficiently long to enable the structures of employment in a period distinctly different from the current period to be studied. The advantage of good documentation makes up for the shortness of the period.

For periods over seven years, employment projections can only be very sketchy. It is rarely possible for the prospects of economic development to be analysed in great detail for ten years ahead. All that can be produced are global projections for a few groups of occupations or levels of training, based in turn on crude economic projections and amounting to no more than indications of trend.

Depending on the choices to be made in each of these categories the methods used to determine the future trend of labour demand will be very different: a general account of these methods follows.

D. MAIN METHODS OF PROJECTING LABOUR DEMAND

The methods are of two main types: the direct and the analytical.

1. Direct methods

The fundamental principle is to select certain economic data regarded as characteristic and to deduce from the probable or desired changes in those data the broad outlines of labour demand trends. The justification for

the procedure is the existence of statistically demonstrated correlations between changes in these characteristic data and those in employment. Various formulas have been used in this type of method, depending on the number and the nature of the economic data selected.⁶

(a) Harbison method⁷

This works on a very simple principle; it relates changes in employment to changes in national income. Three fundamental correlations are assumed; the growth rate of total employment is about half the growth rate of national income; the growth rate of demand for very highly skilled manpower is generally double the growth rate of national income; and the growth rate of middle-level skilled manpower is about three times the growth rate of income.

This method, based on observation of statistical series, can be applied only to long-term projections, since these correlations yield no values over two or three years; for so short a period, factors other than income movements come into play. The projections produced cover only two groups of occupations, very highly skilled occupations and those immediately below them on the scale of skills. They are, therefore, global projections which distinguish, not between specific occupations, but between groups representing a certain level of training. Projections prepared in this way can serve as a useful guide for education policy, by indicating the total long-term needs for types of manpower for which extensive education is a prerequisite, but they are of no help in formulating employment policy or vocational training policy for a period of five years ahead.

(b) Econometric methods

More complex methods have been devised which employ an econometric approach. The principle underlying this work is, according to J. Mouly,⁸ that, subject to differences associated with country size, there is a well-defined growth path for each sector of the economy. When a marked deviation from the normal composition of production is recorded in a country, there is every probability that the lagging sectors will begin to grow at a more rapid pace than the normal in order to approach that normal composition.

The work on this subject was inspired by the research of H. B. Chenery.⁹ In a geographical regression analysis

⁶ J. Mouly, "An approach to some technical problems of manpower planning", *International Labour Review*.

⁷ F. H. Harbison, "The elements of human resource development planning and the integration of manpower planning with general economic development programming", *Lectures on the Labour Force and its Employment*; delivered to First Study Course; 17 September-7 December 1962 (Geneva, International Institute for Labour Studies, 1963).

⁸ J. Mouly, *op. cit.*

⁹ Hollis B. Chenery, "Patterns of Industrial Growth", *American Economic Review*, September 1960, pp. 624-654; Hollis B. Chenery, "The Process of Industrialization", document submitted to the World Congress of the Econometric Society, Rome, September 1965; and Hollis B. Chenery and Lance Taylor, "Development patterns among countries and over time", the *Review of Economics and Statistics*, vol. L, No. 4, November 1968, pp. 391-416.

⁵ This subject will be studied in detail in chapter VI, which deals with ancillary estimates.

covering fifty-one countries, Chenery noted that there was a well-defined pattern of sectoral distribution of production and that it was a function of *per capita* income and population. There have been various applications of these principles to employment projections, differentiated only in the choice of independent variables. At the International Labour Office, for example, a study has recently been made in which this approach is used to determine the evolution of employment by sector. Two types of method were used: in one the evolution of employment is related to product *per capita* and in the other to the major components of final demand.¹⁰ This ILO study shows that models introducing product *per capita* can serve as an instrument for predicting medium-term and long-term employment supply, particularly in countries for which the sectoral distribution of employment for a base year is known. Models introducing the components of final demand can provide only summary guidance on product allocation with a view to development of employment. These methods may, however, be useful to countries lacking adequate statistical data for detailed work on employment projections. Any projections so made must necessarily be of a summary nature. The number of separate sectors considered is always fairly small.

However, while these methods, based as they are on the computation of correlations between employment and certain economic magnitudes, cannot yield sufficiently detailed employment projections, they can be very useful in analysing certain aspects of the evolution of employment, such as the links between sectoral and occupational labour demand and the evolution of production, productivity or other economic magnitudes — energy consumption, for example — in certain branches. The principle involved then becomes very useful and it is for that reason applied in certain phases of the calculations associated with the analytical methods of projecting employment.

2. Analytical methods

The principle of these methods is that of analysing in as much detail as possible the factors which govern the creation of employment opportunities. Instead of trying to construct a simplified model which will make it possible to predict employment on the basis of aggregate economic magnitudes, this approach tries to follow in detail the process by which labour demand is determined.

The outline of these methods is: estimation of the production levels which will be attained in future years; evaluation of the productivity trend; estimation of aggregate employment; and distribution of employment by occupation or level of skill within each sector. At each stage of the process, the factors determining the estimates are analysed in depth. The analysis of each element is as detailed as possible, that is, the number of economic sectors considered individually is high, as is

the number of levels of skill or of occupations considered. However, limitations on the application of these methods to over-refined sub-groupings become apparent very quickly. Inadequate statistical documentation on the factors which determine the creation of employment opportunities, even in highly developed countries, the technical impossibility of projecting trends in extremely specific occupations — for example, opticians or radio repairmen — and the unimportance of such projections constitute valid reasons for not embarking on an analysis which would become bogged down in detail. What, for example, would this kind of projection be used for? It would have a considerable element of uncertainty; and it is, in any event, unnecessary to know requirements for such specific categories of personnel for ten — or even five — years ahead. Adjustments carried out by vocational training institutes every two years would be sufficient. Indeed, very often the problem solves itself, because the workers concerned need only a short adaptation period to learn new functions, provided they have had a satisfactory basic vocational training.

Analytical methods can, on the other hand, be used for medium-term employment projections by occupation or level of skill for a small number of occupational groups: perhaps ten to sixty. Here they can be very useful for defining employment and vocational training policy. This is where they differ from direct methods, which can only be used to develop broad guidelines for education policy. Numerous projection techniques, from very different fields, are employed in these methods: use of models, surveys at enterprises. The choice of technique depends on the constraints of the computation required in the various phases of the projection. Only the fundamental principle is common to all. Many countries have used these methods: the countries of the Mediterranean Regional Project, Argentina, France and Japan. Other examples might be cited.

The only problem to which the methods just explained are not applied is that of the one-year labour demand projection. No doubt an analytical method could be used for determining the evolution of output and productivity for one year ahead, but the results of this method are not necessarily satisfactory, because they do not take account of the degree of utilization of manpower or production capacity at the time when the projection is made. On the other hand, labour market testing methods, in which inquiries are made of a representative sample of enterprises, serve the very useful purpose of indicating the main features of the short-term trend of labour demand in the economy. This subject is outside the scope of this work; the reader is referred to the publications of the Institut für Wirtschaftsforschung (Economic Research Institute), Munich, and, for information on adapting labour market testing for use in studying short-term employment trends, to the surveys made by the Prognosis Institute (Employment Forecasting Institute), Statistika Centralbyran, of Sweden and those of the Centre for the study of the economically active population of the National Institute of Demographic Studies (Institut National d'études démographiques), Paris.

¹⁰ Y. Sabolo, *Sectoral growth of employment* (mimeographed document D.5.1969, of the International Labour Office, 1968).

E. FUNDAMENTAL PRINCIPLES OF THE METHODOLOGY ADOPTED IN THE MANUAL

(a) The analytical methods will be given prominence in this manual. The factors governing the level of employment and its distribution by occupation will therefore be analysed in as great detail as possible. In particular, the projection of labour demand will be closely linked with economic projections;

(b) Labour demand projections will cover all components of the economically active population and not only certain occupations regarded as important and studied in isolation — engineers or doctors, for example. To be consistent, the projections to be carried out require that an over-all view of the evolution of employment be taken;

(c) The methods proposed will differ for individual major sectors of economic activity. Three major sectors will be considered: agriculture, industry and construction, and services. The factors which determine the number and distribution of employment opportunities in each of these sectors differ greatly from sector to sector. That fact justifies resort to the most suitable methods in each case;

(d) Different methods will be proposed depending on the degree of economic development of a country. The characteristics of growth in an economy will not be the same for a country which has long been industrialized and for a new country: in the first case progress proceeds at an almost regular pace without radical changes in the economic structures, which gradually adapt themselves to new technical advances, whereas in the second case progress takes the form of a sudden breaking away from the former rate of economic

development, new structures being established within a few years. The factors to be taken into consideration in predicting labour demand are therefore entirely different in the two types of country;

(e) The methods proposed will vary according to the quality of the countries' statistical information;

(f) The criterion of occupation will be used in this manual and the methods used will therefore be those suitable for projections by occupation. Projections by sector will be dealt with only as one stage in the estimation of labour demand by occupation. The subject of the projection of demand by level of training will be dealt with in a separate section on the utilization of employment projections;

(g) In principle, the methods proposed will be those suitable for medium-term projections (five to seven years);

(h) The type of projection considered is the labour demand projection. However, some account will be given on the methods to be used when the projection has to cover the probable trend of labour supply rather than demand.

Accordingly, the remainder of Part Two of this manual will be devoted to reviewing methods of projecting medium-term labour demand by occupation, in relation to prospects of economic development and the nature of that development. A separate analysis will be made for each of the major sectors of the economy. On the basis of the principles listed above, the three sections of chapter V will deal with agriculture, industry and construction, and services. Chapter VI will cover the ancillary estimates required if the projections are to be used for the formulation of employment policy and education policy.

Chapter V

METHODS OF PROJECTING LABOUR DEMAND

As projection methods vary from one sector of the economy to another this chapter will deal in three separate sections with projection methods for the agricultural, industry and building, and services sectors.

A. PROJECTION METHODS FOR AGRICULTURE

The agricultural sector everywhere has certain characteristics peculiar to itself.¹ Five of these deserve to be mentioned:

1. In most countries, the agricultural labour force is chronically underemployed. Only in a few highly-developed countries is this situation not present. Elsewhere there are varying degrees of surplus labour in agriculture. Nevertheless, the number of persons unemployed is small. In some developing countries, most agricultural workers are underemployed; in countries at a higher level of development, consistent underemployment is confined to certain rural areas or types of farming. Income levels are low, usually much lower than those of urban workers, even when underemployment is not universal;

2. Significant technical advances which demand changes in farming methods have been introduced in the more advanced countries and can be introduced in others. Ways of increasing agricultural productivity are well known: some are simple — the provision of equipment or the use of tractors and mechanical harvesters — whereas others, such as irrigation programmes, require much larger investment; others again, require change in the existing social structures, perhaps by challenging the land ownership system, and the application of modern agricultural production techniques in developing countries almost invariably demands a change in farmer's thinking — it is not enough to give them new technical devices, they must also be taught how to use them;

3. Changes in the numbers employed in agriculture are not closely associated with short-term and medium-term fluctuations in production, as is the case in industry. Such fluctuations may be a contributory cause of rural-urban drift, but there are other causes: farming is not

only a job, but a way of life. One of the main causes of the flight from the land is the desire to change one's way of life. The prevailing discrepancy between agricultural incomes and those of other social classes is a further cause. Non-agricultural factors also play a part: for example, the rapid growth of industry generates substantial labour requirements that can be met only by drawing on agricultural workers. The expansion of education diverts many young people from agricultural occupations. These, rather than changes in production, are the factors that determine the pace of migration to towns and must therefore be analysed in order to forecast the employment level in the agricultural sector. The levels of agricultural productivity and output will be the outcome, rather than the cause, of trends in employment;

4. A distribution by occupation is virtually meaningless. In the industrial and services sectors the division of the employed labour force by occupation is clear-cut, but agricultural occupations are poorly diversified. A distribution by status — landowners, sharecroppers, employees — can be made, but it reveals nothing about occupations. Such classification is useful only in sociological research on trends in farming methods. Landowners and employees may well do the same work and this is why agricultural workers are usually dealt with as a single group;

5. Finally, it is a characteristic feature of employment in the agricultural sector that improved production techniques lead, not to the diversification of occupations within the sector, but to the generation of new occupations outside the agricultural sector in the form of services that are a part of its productive activity. Harvesting contracting enterprises in the highly developed countries are a typical example of this trend, which is not a new one. Much of the technical progress made in agriculture has taken the form of transferring some of the farmer's tasks to industrial or service enterprises outside the agricultural sector. This has happened with the processing of dairy products and in the more distant past with the spinning of textile fibres, such as wool or linen.

This brief analysis of the main features of employment in the agricultural sector shows the need to use special projection methods for this sector. There are two types of agriculture, however: that in which subsistence cultivation is predominant and that in which most of the farmers are already integrated into the monetary economy.

¹ The agricultural sector, for the purposes of this study, corresponds to major group 01 of the *International Standard Industrial Classification of all Economic Activities* (United Nations publication, Sales No.: 58.XVII.7). (A revised edition was published in 1968; see United Nations publication, Sales No.: E.68.XVII.8.)

1. Countries in which subsistence agriculture is predominant

Several difficulties arise in projecting employment in these countries. Firstly, underemployment is widespread and affects a great many adult males. There are two forms of underemployment: visible underemployment, which occurs when a worker's occupation is not full-time, and invisible underemployment, which is the product of the worker's low productivity during his working hours. Secondly, the transformation of agriculture presupposes the gradual development of a new agricultural sector using modern production methods. The development of such a sector calls for a whole range of operations that cannot proceed without the training of skilled labour, and manpower requirements for those operations must therefore be estimated. In any event, agricultural employment does not necessarily decline, as it does in developed countries. In fact, employment may in some cases increase, not only in absolute terms, but as a percentage of the total economically active population.

These three factors have to be taken into account in preparing labour demand projections. The incidence of each one must therefore be evaluated before any projection is attempted.

(a) *Measuring underemployment*

A prerequisite for any study of future employment trends is the most accurate information possible on the extent of underemployment in the agricultural sector. However, such an estimate of underemployment is not in itself sufficient to determine the optimum level of agricultural labour loss from this [subsistence] sector, as expressed by the difference between the currently employed labour force and that which would technically be required to meet the needs of production.

(i) *Estimating underemployment*

The only form of underemployment which is relatively easy to measure is visible underemployment. Two studies of this form of underemployment in agriculture will be used as examples: one was carried out in the United Arab Republic and the other in Pakistan.

a. *Survey of rural employment problems in the United Arab Republic*²

This research was carried out jointly by the Institute of National Planning and the International Labour Office. It included three separate field surveys: an investigation of the nature of employment, its intensity and seasonal characteristics, and its labour requirements by type of production; a survey of the living conditions of the rural population and their attitudes toward change; and case studies on such special topics as income and consumption levels, rural migration, and the role of co-operatives.

For the survey on the nature and duration of employment, a sample of 480 households was drawn in equal

proportions from forty-eight villages, eight villages being selected from each governorate. Of each group of eight villages, the population of four was over 4,000 and of the other four under 4,000. Ten households were selected in each village, eight being agricultural households and two non-agricultural, a pattern which reflects the national percentage of agricultural workers in villages throughout the United Arab Republic. The agricultural households were divided into those having more than four working members and those having fewer. Each of the two types was sub-divided into four strata: landless families, families with holdings of less than two feddans,³ families with holdings of two to five feddans, and families with more than five feddans. Thus, for each village there are eight types of agricultural household and two types of non-agricultural household (one with fewer than four working members and one with more than four working members). The survey period ran from 1 March 1964 to the end of February 1965. The households selected were observed for one whole year; each family was questioned every four days on the subject of the work done during two of the previous four days. This procedure made it possible to gather very reliable data. Visible underemployment was calculated and labour inputs for each type of operation were estimated. Estimates of the productivity of the rural population of the United Arab Republic could be derived from the results of the survey, when regional differences and differences in the size of farming enterprises were allowed for.

The survey of living conditions of the rural population and their attitude towards change covered 1,000 families drawn from the same villages used for the labour record survey. It dealt with the following topics:

Villagers' attitudes towards additional work: whether they were seeking additional work and the reasons for not wanting additional work;

Attitudes towards change of occupation: whether they were seeking different jobs, and if so, why, what types of job they wanted, and where. Further information was sought with a view to determining the circumstances of potential migrants — type of farming enterprise, status, income, intensity of employment during the week of the survey. This second survey provided information on potential rural-urban drift, its nature and its effect on underemployment.

Finally, case studies were carried out in order to provide greater detail.

All this documentation provides a fairly comprehensive picture of the agricultural environment in a developing country, of the levels of productivity and underemployment and of potential rural-urban drift, data which must be known before any projection of future trends in agricultural employment can be made.

b. *Estimate of agricultural underemployment in Pakistan*

An entirely different approach was used in the Pakistan study in which M. H. Khan has attempted an over-all

² United Arab Republic, Institute of National Planning, Research Report on Employment Problems in Rural Areas: Report on Methodology, Field Work and Documentation, prepared by Salib Rofa'el (Cairo, December 1965-March 1966).

³ One feddan equals 4,200.8 square metres.

evaluation of agricultural underemployment in Pakistan.⁴ The available statistical data were inadequate and the resulting limitations of the estimates must therefore be borne in mind.

Firstly, the figures for the total agricultural labour force include all types of workers—the landless, owner-operators (farmers) and tenants. Underemployment rates are obviously not the same for the three categories and such aggregation is therefore arbitrary. Secondly, although the concept of labour force used in the estimate includes children between the ages of ten and fourteen and women, the extent to which they are employed in family labour is not clear. Thirdly, separate norms were assumed for East and West Pakistan. In the latter case, labour requirements were calculated not only for livestock rearing and crop production, but also for crop disposal. These norms were not based on any actual investigations of the techniques and pattern of crop production. Furthermore, no allowance was made for the fact that some of the agricultural labour force might be partially employed in non-agricultural occupations during the period or hours in which they were not working in agriculture. Finally, these estimates indicate the total volume of the unutilized labour force as a percentage of the total hours per man-year available: they therefore provide a measure of annual visible underemployment but yield no conclusion about whether surplus labour is a permanent annual feature or seasonal.

Table 27 gives the estimates computed on this basis: they must, of course, be interpreted very cautiously. What the author does, in fact, is to establish the percentage of unoccupied hours per man-year in the two regions of the country and convert the total unoccupied hours into workers unemployed. In the case of East Pakistan, 37 per cent of the available hours per man-year were unoccupied, which means that the unemployed labour force in the agricultural sector of this region is nearly 6 million persons. In West Pakistan, visible underemployment is much lower: only 8.5 per cent available hours per man-year were unoccupied, giving an unemployed agricultural labour force of approximately 700,000. In theory, therefore, the agricultural labour force of Pakistan would have to be reduced by about 6.5 million workers in order to achieve full employment. This conclusion, however, is a purely theoretical one. If that number of workers were removed from the agricultural labour force, previous output levels could not be maintained with present production techniques.

In East Pakistan, area studies show that the present high level of visible underemployment is due largely to very marked seasonal fluctuations in employment. The withdrawal of these surplus workers would, however, mean that special measures would have to

be taken to meet agricultural labour requirements in peak periods. M. H. Khan writes:⁵

“Even among the small-size farms, where the productivity of labour is very low because of population pressure and the inadequacy of other factor inputs, there is no indication of chronic surplus labour. From the national point of view, this means that the withdrawal of such workers can take place only for a certain period of time . . . unless a total

⁵ M. H. Khan, op. cit., p. 91.

TABLE 27
Estimates of underemployment in agriculture,
East and West Pakistan, 1961

	East Pakistan	West Pakistan
(1) Total agricultural labour force (in thousands)	15,860	7,900
(2) Approximate number of available hours per man-year	2,200	2,600
(3) Total number of livestock units (in thousands)	22,670	26,920
(4) Livestock units per agricultural worker	1.42	3.40
(5) Number of working hours required for one livestock unit per year	300	300
(6) Number of working hours required for all livestock per worker per year ^a	426	1,020
(7) Number of hours available per man-year for other agricultural work ^b	1,774	1,580
(8) Total cropped area (in thousands of acres)	25,800	35,800
(9) Average number of hours required per acre per year	600	300
(10) Average number of acres per worker required for full employment ^c	2.96	5.27
(11) Cropped area per worker (acres) ^d	1.62	4.53
(12) Percentage of time occupied in agricultural work per worker ^e	55	86
(13) Percentage of time per worker unoccupied	45	14
(14) Number of unoccupied hours per worker per year $\left(\frac{13 \times 7}{100}\right)$	798	221
(15) Unoccupied hours as a percentage of the total number of hours available per man-year for livestock rearing and cropping	37	8.5
(16) Preceding figures as converted to unemployed labour force ^f	5,868	679
(17) Real employment of the agricultural labour force (in thousands)	9,992	7,228

SOURCE: M. H. Khan, *The Role of Agriculture in Economic Development: A Case Study of Pakistan* (Wageningen, Centre for Agricultural Publications and Documentation, 1966).

^a Number of working hours required per livestock unit multiplied by number of livestock units per agricultural worker.

^b Approximate number of available hours per man-year (2) minus number of working hours required for livestock rearing (5).

^c These figures are derived by dividing the number of hours available per man-year for other agricultural work (7) by the number of hours required per cropped acre per year (9).

^d These figures are derived by dividing total cropped area (8) by total agricultural labour force (1).

^e These figures are derived by dividing (11) by (10).

^f These figures are derived by dividing the percentage of unoccupied hours (15) by 100 and multiplying the result by the total agricultural labour force (1).

⁴ M. H. Khan, *The Role of Agriculture in Economic Development: A Case Study of Pakistan* (Wageningen, Centre for Agricultural Publications and Documentation, 1966), pp. 88-91.

reorganization of the cropping pattern, the addition of capital and other such productive inputs takes place."

In West Pakistan, visible underemployment seems to be confined to small-size farms and to certain areas where non-agricultural employment is particularly scarce. On the whole, underemployment seems to be caused by both seasonal fluctuations and the low level of productivity.

(ii) *Usefulness and limitations of measures of underemployment*

These two studies are complementary: that carried out by the United Arab Republic has the merit of providing a methodology for detailed analysis of underemployment situations in agriculture; on the other hand, the study by M. H. Khan, which attempts an overall estimate based on data which are probably not entirely reliable, indicates some possible uses for such research and the risks associated with its interpretation.

Another method of assessing underemployment considers, not the utilization of a worker's time, but his productivity level, estimated on the basis of his income. An acceptable level of employment may be deemed to have been reached by workers whose contribution to production is at least equal to a specified critical level, which will be the average productivity per worker at a given time. Underemployment will then be assumed to occur whenever the productivity of a marginal worker is lower than this average productivity; the worker's productivity is roughly assessed on the basis of his income, since there appears, as a rule, to be a direct link between productivity and income.⁶

A measure of visible underemployment cannot be used to establish, by a simple process of subtraction, a target for the evolution of the future agricultural labour force. Underemployment in this sector cannot be abolished by accelerating the drift to towns. Otherwise, given the production techniques used and seasonal fluctuations in the occupational activities of farm workers, the necessary manpower would be lacking, at least at the peak period.⁷ On the other hand, the measurement process itself is essential because it alone enables the most characteristic situations of underemployment to be identified and means of changing them to be worked out.

However, the evolution of agricultural production, like that of employment, proceeds by modification of the production structures. Accordingly, the work of projecting employment must take the form of studying the consequences on employment of changes contem-

plated in the field of production. What specific labour demand will the modernization of agriculture necessitate?

(b) *Skilled manpower requirements for carrying out the modernization of the agricultural sector*

Many factors, from very different fields, have to be taken into consideration in evaluating manpower needs for the creation of a modern system of agriculture. The first task is that of calculating skilled manpower needs for large farms working for export. The future development of world markets is the most difficult element to assess. Technical manpower requirements for a specified output, on the other hand, are fairly easily projected. Another problem is the transition from traditional to modern agriculture. This transition requires that a series of measures be undertaken, chief among which are, in all countries, the development of agricultural extension and development services, and, in some instances, irrigation work, land settlement and land reform.

Employment projections in this sector are based on an analysis of manpower requirements for implementing such measures, and not on the projecting of a target for agricultural output and of over-all productivity prospects. These specific manpower requirements must therefore be assessed and the numbers needed for the extension of modern agricultural techniques and the provision of development services to farmers estimated. Estimation of these numbers presupposes that an overall plan has been prepared which determines the magnitude of the efforts to be undertaken and the stages at which they are to be implemented. Employment opportunities can be projected only if such a plan exists. The manpower demand projection should cover two categories of personnel: development personnel, responsible for providing development services to rural workers, and implementation personnel, which comprises farmers trained in modern production methods. Norms must be applied in order to determine what development personnel are needed. The [French] Bureau for the development of agricultural production,⁸ for example, utilizes the concept of "development service intensity". Several categories of development personnel are used: at the base are development officers, who have completed a technical training course after primary education; next are instructors, technicians who have completed the first stage of secondary education; last come the group leaders, who must hold a certificate of full secondary education. Over-all supervision is in the hands of graduate experts. The officers at the highest levels are not agricultural, but administrative staff. It is, however, desirable to include them in any estimate of manpower needs made in connexion with the study of agricultural employment, even if their jobs are subsequently treated as part of the administrative services for accounting purposes.

⁶ J. Mouly, "A few reflections on underemployment and the problems of quantifying employment targets", Fourth Inter-regional Seminar on Development Planning, held at Accra (Ghana), 4-13 December 1968 (Document ISDP4/C/R.2); and R. Nurkse, "Excess Population and Capital Construction", *The Malayan Economic Review*, Vol. II, No. 2, October 1957, pp. 1-11.

⁷ On the interpretation of underemployment situations, see Gunnar Myrdal, *Asian drama. An inquiry into the poverty of nations*, Vol. III (New York, Pantheon, 1968), Appendix 6.

⁸ France, Bureau pour le développement de la production agricole (Bureau for the development of agricultural production), *Étude sur l'enseignement et la formation professionnelle agricole dans les pays francophones d'Afrique tropicale et à Madagascar : Rapport général* (Paris, 1963).

The number of farmers to be trained must also be calculated. In Upper Volta the target of training of 20,000 heads of agricultural enterprises annually has been adopted for 1965-1985.⁹

In many cases, in order to produce the desired effect, agricultural extension and development services must be accompanied by a programme for irrigation, the settlement of unused land or land reform.

A well-established system of water storage can bring about the improved yields and the longer growth periods, but such a system will be fully effective only if the management of farms and the training of the farmers keep pace with the new situation. The new employment structures must therefore be anticipated and the number of persons to whom additional vocational training is to be given estimated.

Moreover, concern for agricultural employment often induces countries to make plans for land settlement and the utilization of periods of underemployment. In Puerto Rico, a programme of self-help and land settlement has enabled 40,000 families to be resettled in 263 rural communes. In Upper Volta, population pressure, the scarcity of good land and the extremely high level of rural exodus have led the Government to prepare a plan of agricultural land use for an area covering 36,000 hectares and to encourage 100,000 persons to migrate to it. Educational centres, wells and small dams have been built. India in 1960-1961 introduced a system of rural work projects in order to create wage-earning jobs during the slack seasons for agriculture. Under the scheme work was to be provided for 100,000 persons during the first year of the Fifth Plan, for 400,000 or 500,000 during the second year, for about 1 million during the third year, and 2.5 million during the final year.¹⁰ Some acquaintance with these projects is essential for projecting employment because they will have a marked impact on the evolution of the agricultural labour force and on training requirements in future years.

A further essential factor to be considered when employment projections are being prepared for a developing country is land reform. It must be known whether the country concerned intends to embark upon land reform. Some land reform programmes have no effect on the level of employment. Others, however, provide a genuine stimulus to the development of economic and social activities and to the utilization of the labour supply. Everything depends upon the changes in the man-land ratio which result from reform. Will the number of jobs created, for example, be greater than the number of jobs abolished, or, in the case of the partition of a large estate in Latin America, will the abolition of wage-earning jobs on the estate be offset by the number of newly-generated jobs for small land-owners and family workers. How favourable will the end

result be?¹¹ Moreover, the new farms will usually be handed over to agricultural workers who have received additional vocational training and their numbers must therefore be known.

(c) *General pattern of change in the economically active agricultural population in a developing country*

The economically active agricultural population can be regarded initially as a homogeneous closed population. Accessions to this population are represented by the attainment of working age by the children of farming families. It is assumed that all the children will work on the farm as soon as they reach the age at which, by tradition, they begin to take part in their parents' occupational activity. Accessions to the economically active population are therefore governed by the number of births, as reduced by infant mortality. Estimates of this factor are made on the assumption that the number of births has been correctly recorded in the country or, at least, that reliable estimates have been made, and on the more important assumption that these births can be distributed by social environment, so that the number of children born to agricultural families can at least be roughly estimated.

A second assumption is made, that the activity rates of the different categories of workers remain the same — in other words, that men, women and children in farming families take part in productive activity in the same fashion as in the past. This assumption means, in practice, that all the members of the family are economically active except for young children, since what is considered is, not the intensity of each worker's employment, but the fact that for some of his time he does some work for the farm.

The mortality rates applicable to the country as a whole are applied to this estimate of the agricultural labour force. Two other factors must also be taken into account: the fact that young people from farming households who attend school full-time do no work on the farm and must be subtracted, and the impact of rural migration to towns, which must now be considered.

The flight from the land has accelerated in all developing countries. It is one of the factors largely responsible for the reduction in the population of the agricultural sector. This movement, which transfers workers from rural areas to towns, is nevertheless poorly documented; there are no accurate statistical estimates of its magnitude, even for a single country. Furthermore, the factors which cause this exodus and determine its level have not been analysed; they can, however, be identified.¹²

Educational progress plays an important role. The spread of literacy among the young people in rural areas and the longer period of schooling which some of them have enjoyed have turned many young people against their parents' traditional occupational and

⁹ Société d'études pour le développement économique et social (SEDES), *Problèmes de l'emploi en Haute-Volta* (Paris, March 1965).

¹⁰ "Fuller use of rural manpower", document of the World Food Congress, Washington D.C., 4-18 June 1963, p. 5.

¹¹ M. J. Sternberg, Agrarian reform and employment, with special reference to Latin America, *International Labour Review*, Vol. 95, Nos. 1-2, January-February 1967, pp. 1-26.

¹² P. C. W. Gutkind, "African Responses to Urban Wage Employment", *International Labour Review*, Vol. 97, No. 2, February 1968.

induced them to leave rural areas in order to find in towns employment more in keeping with their training.

This movement has been strengthened by "the determination of a large number of people to seek alternative ways of making a living".¹³ The desire to live in a town and take up non-agricultural employment provides motive enough for many inhabitants of rural villages, quite apart from any economic considerations that may occur to them. Indeed, the prospect of finding an urban job is usually not taken into consideration, so that the rural exodus is reflected in a steep rise in urban unemployment. P. C. W. Gutkind says that between 10 and 20 per cent of the population of the larger towns such as Brazzaville, Kinshasa, Accra, Ibadan, Lagos, Abidjan, Nairobi and Dar-es-Salaam are either totally unemployed or subsist on very casual employment.¹⁴ The prospects of a higher level of living for farmers as a result of crop diversification and the development of trade do not, in general, seem to be an important consideration in the migrants' decision — a matter in which they differ from developed countries.

This simple enumeration of the factors governing rural-urban drift shows how difficult the projection process is — hence the necessity to use two or three separate assumptions based on different rates of exodus. The total economically active agricultural population of a developing country is estimated. From the volume of employment thus derived is deducted the number of skilled workers required for the existing modern agricultural sector and the modernization of the traditional agricultural sector, estimated by the method explained earlier. The result is the estimated number of the economically active agricultural population having no special vocational training who will be employed either as ordinary labourers on modern farms or in traditional subsistence agriculture.

These estimates may be compared with the true demand for agricultural labour, if it has been calculated in connexion with the measurement of underemployment by the methods described earlier. The comparison will determine whether labour surplus in the agricultural labour force will be substantial or slight in future years, given the probable growth in the output of agricultural exports and of subsistence commodities.

(d) *Conclusion concerning future trends in agricultural employment in the developing countries*

It was stated at the beginning of this chapter that agricultural employment in developing countries might not necessarily decline either absolutely or relatively, and might even increase. At the beginning of the development process, most of the population are employed in the agricultural sector. Non-agricultural employment is very low. In the first years of the development process, growth in non-agricultural employment is inevitably slight, since it depends primarily on the extent to which industry has been able to expand. At the same time the

percentage annual increase in total population in many countries is very high. If, therefore, agricultural employment, as a percentage of the total economically active population, is to fall in a country in which the annual rate of population growth is 1.5 per cent and the proportion of non-agricultural employment in the economically active population is 25 per cent, non-agricultural employment must rise by 6 per cent annually in the early years of development and fall to 3 per cent when non-agricultural employment represents 50 per cent of the total economically active population, a result which, in many countries, will not be attained for a very long time.¹⁵

This pattern of agricultural employment in the developing countries has been described in another way by Y. Sabolo,¹⁶ in the following passage:

"During the phase 1_v, employment in the traditional sector increases absolutely, for expansion of the non-agriculture branches of the economy is not sufficient to absorb the rise in the active agricultural population (this pattern corresponds fairly closely to the movement of agricultural employment in Algeria in recent years).

"In phase 2, total agricultural employment becomes stationary as the result of a double trend: employment on subsistence production diminishes (phase 2_v) because of transfers to the non-agricultural branches or to the incipient modern sector of agriculture; but this fall is more or less balanced by the emergence and subsequent development of the modern sector (phase 2_M). The decrease in employment on subsistence production is more or less rapid, according to the system of farming.

"The introduction of modern methods into farms promotes the emergence of a modern agricultural sector with a gradually rising level of labour productivity — favoured *inter alia* by the expansion of other branches, but not growing as fast as employment in the modern sector; consequently, at the beginning of the process the curve E_M takes an upward course. This corresponds fairly closely to recent developments in such countries as Israel, Yugoslavia and even the USSR (in the two latter, the statistics relate only to the number of employed persons in the modern sector).

"Phase 3 corresponds to a subsequent stage of development in which total employment decreases. Existing side by side with residual "market" employment (E_m), employment in the modern sector (E_M) tends to diminish under the double effect of transfers from agriculture to other branches of the economy and — mainly — of increasing productivity. This is what has occurred in most industrialised countries of the western world."

¹⁵ F. Dovring, "The share of agriculture in a growing population", *Monthly Bulletin of Agricultural Economics and Statistics* Vol. 8, Nos. 8/9 (Rome, FAO, 1959).

¹⁶ Y. Sabolo, op. cit., p. 20.

¹³ *Ibid.*

¹⁴ *Ibid.*, p. 137.

2. Countries in which the subsistence sector is non-existent or negligible

In countries in which the agrarian structure no longer includes a subsistence sector or includes only a negligible number of farms of this type, underemployment is lower but still present in many instances; moreover, the absence of an association between production changes and changes in the numbers employed is again notable.

A clear distinction must therefore be made between employment targets for the agricultural sector, which take into account the number of workers required to attain given levels of output and productivity, and estimates of the probable trend of agricultural employment, which allow for rural-urban drift and for the desire of some older workers to remain on the land. The two estimates of employment in agriculture thus obtained may differ considerably: in the first, only technical factors are considered, whereas in the second human factors are predominant. Both estimates are necessary: a comparison of the results shows the difference between the desirable level of employment and its probable level in future years.

(a) *Methods of fixing employment targets*

These methods can be used only for long-term projections covering, say, twenty years; they are based on the assumption that present underemployment will have been entirely eliminated in that time and that the level of employment will be exactly that appropriate to production requirements and to the maximum labour productivity which production techniques — in so far as their development can be foreseen — will permit.

Several techniques can be used. One simple estimation takes the form of determining how many persons a farmer will be able to feed in, for example, 1980. International comparisons are used in this connexion to provide a crude measure of the productivity of agriculture in various countries. The figures for the future population of the country concerned can be employed to establish the number of farmers. In this method it is assumed that agricultural production has no purpose other than to meet the country's needs. Some work done in Hungary has used this method for checking purposes; it was found that one farmer would feed thirteen to fourteen inhabitants in 1980, a figure which is a little higher than that for Sweden in 1955 and very much less than that for the United States for the same date.¹⁷

The Hungarian forecasts, however, were based on more detailed calculations, which covered changes in foodstuffs requirements in Hungary and changes in production techniques. Another example of this type of research is the studies made in France by the Centre d'études économiques.¹⁸ The most modern techniques

available were applied to all areas under cultivation in 1962. The result was an increase of about 35 per cent in output and a volume of employment of 1.7 million persons. This calculation, of course, is concerned essentially with possible changes in productivity where the area under cultivation remains the same; the levels of production and employment are merely consequences. In this first estimate, the projected level of production greatly exceeds France's needs in 1980. A second assumption can be introduced which limits the increase in production to the country's foreseeable needs: in this case the total area considered is reduced, production techniques are the same, but the level of employment is itself reduced in proportion to the limitation on areas under cultivation. This computation yields a volume of employment of about 1 million persons. This figure must be compared to that for agricultural employment in France in 1962: about 2.5 million.

Another method was used in studies made by the European Economic Community.¹⁹ In these it is assumed that the 1964 level of productivity of specialized pilot farms will be attained in 1980. From that assumption can be derived the maximum rate of decline in the numbers employed during the period studied, given the desired level of output. The report cited below states that, in these circumstances, for the six countries concerned the resulting rate of decline in numbers employed would be very high — of the order of 5 per cent per year, whereas during recent years the rate has been between 2.5 and 3 per cent.

These estimates are necessarily crude: productivity is estimated in isolation, employment being treated as the consequence of probable changes in production and productivity. In fact, this is not true of medium-term developments: patterns of change in the economically active agricultural population depend on factors associated with employment itself, such as the flight from the land of certain workers, and productivity is a resultant.

(b) *Determination of probable trends in agricultural employment*

The report of the European Economic Community on agricultural employment prospects points out that advances in agricultural productivity are the result, not only of technical factors which negatively influence employment, but also, to some degree, of a decline in employment which is independent of these factors.²⁰ The causes of this fall in employment must therefore be considered and their exact incidence assessed.

There are two components in this fall in the numbers employed: rural-urban drift, i.e. the movement of agricultural workers into other employment sectors, and reductions due to factors other than that movement. The latter component will be discussed first.

¹⁷ J. Timar, "Planning the Labor Force in Hungary", *Eastern European Economics*, vol. IV, Nos. 2-3, 1966, p. 73.

¹⁸ France, Centre d'études économiques, "*Population active agricole masculine techniquement nécessaire*" (Paris, May 1964).

¹⁹ European Economic Community, "*L'emploi agricole dans les pays de la Communauté économique européenne, vol. II, Évolution et perspectives*", Série Politique Sociale 8 (Brussels, 1964).

²⁰ *Ibid.*, p. 48.

(a) Participation by members of the family in the work of the farm is on the decline. Farmers' wives, who used to do a great deal of farm work, do much less as the level of living rises. Their contribution becomes specialized and is confined to the poultry-yard or kitchen garden, and to some help in busy periods. The period of compulsory education for farmers' children has similar effects. As an increasing number of these children stay on at school after the period of compulsory education has ended, the proportion of the work of the farm which they used to do falls — to zero in many cases.

Until very recently, elderly farmers did not retire. Their occupational activity usually declined but did not cease. The development of pensions schemes for farmers and farm workers, and the system under which, in some countries, farmers are offered compensation for giving up their farms, have brought about a change in that pattern. Retirements, while they do not occur systematically in the case of all farmers and farm workers over sixty-five, are more numerous.

The effect of these two factors is to reduce the economically active agricultural population and the total economically active population, since those who retire take no other employment and those who would have entered the economically active agricultural population do not do so but nevertheless take up no other employment. The latter category includes men who stay at home and young people who prolong their schooling.

(b) The second set of factors to be considered is that determining the level of rural-urban drift, this term being taken to mean the movement of agricultural workers to other occupations. Its most important demographic effect is that on the age structure of the farming population. Because the fall in the agricultural labour force is a movement which began many years ago in developed countries and mainly involved young people, the population pyramid for agricultural workers has been distorted in those countries; the numbers of the young generation tend to decline from year to year. The number of young agricultural households falls consistently. This movement is sometimes at least partly offset by the maintenance of a fairly high birth-rate. The generations from which migrants are recruited are therefore declining and this may slow down the rate of drift.

What are the factors which lead to a decision to abandon work on the land? There are few analyses available on this subject, since it has been very rarely investigated. The following list includes the principal factors involved, factors associated with agriculture and external factors being listed separately: the first group must include inadequate incomes, rejection of a very restrictive and somewhat isolated way of life, and changes in methods of cropping and livestock rearing; the second group comprises employment opportunities outside agriculture, the level of non-agricultural wages, the degree of urbanization of the region, and the nature of non-agricultural occupations in the region.

The effect of each of these factors varies with the age of the potential migrant. No model for patterns of change in agricultural employment which takes all

these factors into account has yet been devised.²¹ Several simplified methods have been used or proposed which take into consideration some of the factors mentioned.

In France, a demographic method was used for the preparation of the Fifth Plan. It takes as a basis the population pyramid for agricultural workers and it assumes that, by 1970, the rates of drift per generation will remain the same as in 1954-1962. This method, in effect, assigns a precise value to the first factor mentioned in the foregoing list as governing rural-urban drift and incorporates the other factors in the form of a composite index representing the rate of exodus per generation. The use of a constant rate reflects the assumption that the movement away from agriculture is governed essentially by sociological considerations — the continuing gap between agricultural and non-agricultural incomes, rejection of the farmer's way of life — and that these factors are relatively constant over time for each age group. Hence the only variable is the age-specific composition of the population considered. This assumption over-simplifies and results obtained by using it were corrected to take account of the acceleration in occupational changes among young people and of the retirement of older farmers, both of which phenomena are being encouraged by government measures. Rural-urban drift, taken on the basis of the first assumption to be 95,000 separations per year for 1962-1970, rose to 115,000 separations. Agricultural employment in 1970, estimated in the first case at 3 million persons as against 3,885,000 in 1962, declined to 2,830,000.²² Preliminary figures on the trend of agricultural employment in France since 1962 show that this second estimate was still a little too high and that the reduction in the economically active agricultural population was slightly larger than anticipated.

Another method has been proposed by the European Economic Community; it uses one of the factors listed earlier, the level of agricultural incomes as compared to non-agricultural incomes. In this case it is assumed that the ratio between these two types of income will not become more unfavourable and that therefore, in the absence of any policy for raising agricultural prices, improvements in productivity must necessarily be the same in the non-agricultural and agricultural sectors if the ratio is to remain constant. If it is assumed that in these circumstances the over-all productivity of the economy will increase by 4 per cent annually in the Community as a whole by 1980 and that agricultural output will rise during the same period by only 2.5 per cent, the minimum acceptable rate of decline in agricultural employment would be 1.5 per cent per annum. The rate thus calculated, assuming stability of the terms of trade between agriculture and other sectors, will have

²¹ But it should be pointed out that the Société d'économie et de mathématiques appliquées (SEMA) in France is at present studying a model of this type at the request of the European Economic Community.

²² France, Commissariat général du Plan d'équipement et de la Productivité, *Rapport général de la Commission de la main-d'œuvre pour le V^e Plan*, (General report of the Manpower Commission for the 5th plan) (Paris, La documentation française, 1966), pp. 60-62.

to be adjusted if the assumptions as to price are different.²³ These estimates yield minima which seem most unlikely to occur. In the recent years, agricultural employment in fact fell by 3 per cent annually in the countries of the Community. This rate can probably not be reduced by half.

The final research method to be considered is that of studying recent changes in the number of farms and their size. A matrix can be constructed which shows, for a given past period, what happened to 100 farms of a specified size, with a specified distribution of output: how many have remained as they were, how many have been merged into larger farms, and how the farms so created are distributed by size. Will this trend in farming structures be maintained in future years? Will the process of concentration accelerate? Various assumptions can be utilized. This method takes into consideration several of the factors which determine rural-urban drift: the level of farmers' incomes, the effects of changes in the population pyramid, and changes in cropping and livestock rearing.

None of the methods described gives direct statistical results. The merit of the method of constant rates of drift by generation is that it provides a reference projection rather than a forecast, on the basis of which additional assumptions can be introduced as variants. In the absence of a model incorporating all the factors which govern agricultural employment, this method seems the most reliable one for studying the probable evolution of employment.

No account will be given here of projections of agricultural employment based on a prior determination of the levels of output and productivity which will be attained in future years. The list given earlier of factors associated with employment in this sector would seem to preclude recourse to this method. If, however, agricultural underemployment has completely or almost completely been eliminated in a country, most of the objections to the use of this method are removed. This is the case, for example, in the United States of America. In such cases the level of output can be forecast and the probable trend of productivity estimated in order to derive a figure for probable employment. This approach was used in a study by the United States Bureau of Labor Statistics on employment prospects for 1964-1975. Even in this case, however, a study of trends in farm size, the principal factor in increasing productivity, was carried out.²⁴ A mere assessment of the extent of possible improvements in productivity is therefore not enough.

B. PROJECTION METHODS IN INDUSTRY AND CONSTRUCTION

The industry and construction sector covers the following divisions: mining, manufacturing, construction, and gas, electricity and water services, as they are

defined in the international classification of economic activities. These four divisions are sub-divided into twenty-eight major groups.²⁵

A common method of projecting employment can be worked out for all divisions which have the same major characteristics, these being that employment in them is closely associated with developments in production and productivity and that the level of productivity largely determines the occupational distribution of employment. These characteristics are peculiar to the industry and construction sector and are not found in either agriculture or services: there the link between output and employment is much weaker and productivity has far less influence on the occupational distribution of employment.²⁶

Traditionally, employment projections for individual industries are made in two stages: the purpose of the first stage is to determine the trend of the total employment level by industry; the second distributes the total employment of each industry by occupation. This procedure will be followed here.

1. Projection of the level of total employment in each branch of the industrial sector

Because of the interdependence of output, productivity and employment in the industrial sector, the best method is to abstract the total numbers employed from the output and productivity projections for the individual divisions. The formula used is:

$$E_n = K E_1 \frac{kP_n}{K_{pn}}$$

in which E_n represents numbers employed in the division in the final year of the projection, E_1 is the numbers employed in the base year, kP_n is the rate of growth of total output in the division between the base year and the final year of the projection, and K_{pn} is the rate of growth of total productivity per hour worked in the division between the base year and the final year of the projection.

This formula has been utilized in many countries. Table 28 shows an example of this type of estimate for Greece.

There are two prerequisites for the use of this method: the level of total output in each major division must be estimated for the final year of the projection and data of the required degree of accuracy must be available on the probable trend of productivity.

²⁵ *International Standard Industrial Classification of all Economic Activities* (United Nations publication, Sales No.: 58.XVII.7). (A revised edition was published in 1968; see United Nations publication, Sales No.: E.68.XVII.8.)

²⁶ These observations are justified only if the industrial sector excludes the traditional handicraft production of certain countries, in which underemployment is very high; in view of the characteristics of this handicraft sector, it would seem preferable not to deal with it in conjunction with industrial enterprises. The projection methods to be used in this sector are the same as those which are proposed in the next section for the services sector.

²³ European Economic Community, op. cit., p. 49.

²⁴ United States of America, Bureau of Labor Statistics, *America's Industrial and Occupational Manpower Requirements, 1964-1975* (Washington 1966), pp. 12-15.

TABLE 28

Projection of average annual rates of growth of output,
productivity and employment in industry, Greece, 1965-1974

	Output	Productivity	Employment
Mining	10	6.4	3.4
Manufacturing	9.3	6.0	3.1
Gas, electricity and water services	13.0	8.9	3.8
Construction	8.8	5.7	2.9
TOTAL	9.5	6.2	3.1

SOURCE: Organisation for Economic Co-operation and Development, *The Mediterranean Regional Project: Greece* (Paris, 1965); tables 5, 6 and 46.

(a) Establishing the level of total production

This operation cannot be performed by specialists in employment forecasting; they have to use economic projections, usually prepared independently and not solely for the purpose of employment projections. The nature of the operation varies depending on whether a detailed economic plan has been prepared or an outline projection made of probable trends, or whether there is no detailed projection at all of future output.

In the latter event, the method of projecting employment by abstracting from the levels of output and productivity cannot be used and resort must be had to the summary methods explained in chapter IV. If either of the other situations obtains, output estimates for each division can be derived from economic or planning projections. The degree of detail in these estimates will vary, depending on the methods of economic estimation used in preparing them. Some comments are needed on this point:

(i) If an accurate estimate is to be made of the future level of industrial output by division, the final demand for industrial products must first be estimated and an input-output table constructed. The components of final demand are all goods made for sale to consumers²⁷ or for export. An estimate of final demand presupposes an analysis of probable domestic consumption and its distribution by product. In addition, assumptions have to be made as to the volume of exports in future years. These operations constitute market research at the national level — a difficult undertaking.

A knowledge of final demand is not enough, however. Not all industries produce for direct consumption or export. Many of them supply primary commodities or semi-finished products which are subsequently used by the sectors which produce finished products. Calculation of the output levels of the sectors producing raw materials and semi-finished products presupposes the use of input-output tables. From these tables can be calculated the anticipated output levels of each of these industries on the basis of a specified product structure of the final demand for industrial products.

²⁷ Individuals or enterprises; in the latter case, they may be capital goods (machinery, buildings).

The construction of an input-output table, in turn, presupposes a knowledge of the technical coefficients for linking the output of materials, power and intermediate goods to the final output of consumable products. For example, one must know the quantity of steel used in motor vehicle construction for a given level of vehicle output. This information is particularly difficult to obtain because the technical coefficients change with time, either because the quantities of power or raw materials used to obtain a given output are reduced through the introduction of new techniques or because substitute raw materials require the use of, for example, plastics instead of wood.²⁸

(ii) In the absence of this information, other methods may be used. Multiple regression analyses may be employed to relate the past trend of the output of each division to total output and to such components of the gross national product as investment expenditure, consumption expenditure or State expenditure on the sectors concerned.²⁹

(iii) In countries in which statistical data on industrial production and its factors are very poor, a direct estimate of the level of output by division may be attempted. Recourse to this method may be justified in the case of, for example, new industries in a developing country which has as yet very little industry. A production target is set on the basis of an analysis of the prospects for domestic consumption or export of the output of the industries concerned. In this case there is no need to resort to complex input-output tables.

(b) Determination of probable productivity trends

J. W. Kendrick has shown that rates of growth of productivity vary greatly from one industry to another and that their movement is extremely irregular. This irregularity is not always explained correctly, even in countries where statistical and technological data are as reliable as in the United States of America.³⁰

This whole subject is hardly ever considered in sufficient detail when economic projections are being prepared and must therefore be discussed here, difficult though it is to deal with.

Two methods can be used: if there is a statistical series for the past trend of productivity in every branch of industry, the probable future trend is determined by correcting that past trend (see table 29); if statistical series are not available, the rate of growth of productivity is estimated directly by reference to foreign examples.

²⁸ On the techniques of construction and use of input-output tables, see: W. W. Leontief, *The Structure of the American Economy, 1919-1939: an empirical application of equilibrium analysis* (New York, Oxford University Press, 1951); and E. C. Malinvaud, *Initiation à la comptabilité nationale* (Introduction to national accounts) (Paris, Presses universitaires de France, 1958).

²⁹ For further details, see United Nations Educational, Scientific and Cultural Organization, *Methods of Long-term Projection of Requirements for and Supply of Qualified Manpower* (Paris, 1967).

³⁰ J. W. Kendrick, *Productivity Trends in the United States* (Princeton, Princeton University Press, 1961).

TABLE 29

France: recent trends in average annual rates of hourly labour productivity in various divisions of industry and forecasts for 1970

Division	Average annual rates	
	Plan (1962-1970) (percentage)	(1956-1962) (percentage)
02 Agricultural production and food manufacture	3.8	2.8
03A Solid mineral fuels	2.0	3.5
03B Gas	8.6	12.8
04 Electricity, water and miscellaneous .	7.4	5.5
05 Petroleum, natural gas and motor fuels	4.2	2.4
06A Construction materials	5.6	5.3
06B Glass	4.3	5.8
07 Iron ores and iron and steel products	4.7	3.3
08 Non-ferrous ores and metals . . .	3.3	4.4
09A Products of basic metal industries and fabricated metal products	3.9	2.7
09B Machinery and mechanical apparatus	3.8	3.9
09C Electrical machinery and apparatus .	4.4	5.2
09D Motor vehicles and cycles	4.2	5.2
09E Shipbuilding, aircraft manufacture and armaments	5.0	5.3
10 Products of the chemical and rubber industries	6.2	7.0
11A Textiles	5.2	5.7
11B Wearing apparel	4.5	6.0
11C Leather	4.5	5.1
12A Products of the timber industry . . .	3.8	4.7
12B Pulp, paper and paperboard	4.6	5.3
12C Printing and publishing	3.6	2.5
12D Manufacture of plastic products and other industrial products	5.0	7.4
13 Construction and public works . . .	4.7	4.1

SOURCE: France, Commissariat général du Plan d'équipement et de la productivité, *Rapport général de la Commission de la productivité pour le V^e Plan* (General report of the Productivity Commission for the Fifth Plan) (Paris, La documentation française, 1967).

(i) *Correction of past trends*

The following factors must be taken into consideration:

a. How fully is the employed labour force utilized and what is the present production capacity of the division? When underemployment is due to an unfavourable economic situation, there is a productivity reserve which will be used in coming years, when output will again increase. Hence, the growth in numbers employed will be smaller than if production capacity and labour are fully utilized at the beginning of the period for which the projection is made;

b. Changes in production techniques represent the second factor to be taken into account. What new technical advances will be introduced in the coming years and what will their impact be on manpower requirements? Will future capital investment lead to savings in manpower? Do the working methods used in most of the enterprises in the division concerned need to be rationalized?

In research recently carried out in the United States of America in connexion with the preparation of employ-

ment projections for 1975 special attention was paid to these factors. The analysis of technological advances in the metal-working industries, for example, shows that these advances will significantly increase productivity through greater use of automatic control instruments, automatic handling and numerically-controlled machines;³¹

c. Changes in the distribution of enterprises by size have an important influence on productivity trends. This is especially true of divisions in which the number of enterprises is very high and a marked tendency towards concentration is anticipated.

This is not a method which yields mathematically exact results, since the rates for future years cannot, as yet, be computed by using a model, because the necessary statistical data are not available. It can be used only in countries which have reached a certain level of industrial development: their growth rate has for several years been relatively steady; new technical advances are constantly being applied but cause no sudden breaks in the country's economic development, as they may in a developing country which decides to create a new industry out of nothing; changes in trends are usually slight. It is not only impossible to use this method in developing countries, because of the lack of statistical data on past trends, but it might be dangerous, since to extrapolate by correcting the productivity trend of an industry which was composed of a small number of poorly-equipped enterprises, in order to estimate the future productivity level of a section of industry in which there will be a preponderance of new and modern enterprises within a few years, is impossible. An experiment of this type in the United Arab Republic has clearly shown the drawbacks of the method; the projected productivity rates grew much too slowly in relation to the country's industrial development requirements. In such cases the productivity level for future years must be estimated directly.

(ii) *Estimating the productivity level by reference to foreign examples*

This method involves some complex analysis: moreover, the inadequacy of the statistical documentation available makes it difficult to apply. Productivity per employee is greatly influenced by the production techniques which are used. Selecting a productivity level means, in effect, selecting certain production techniques and, accordingly, a given volume of capital investment, a given organization of the work and a given distribution by occupation for workers employed in the industry concerned. These factors must all be taken into account when a foreign example is used. Can the required level of investment be attained and the necessary labour be recruited in the country which is the subject of the projection? These questions must first be asked in the initial phase of the projecting procedure: the second

³¹ United States of America, Bureau of Labor Statistics, *America's Industrial and Occupational Manpower Requirements, 1964-1975* (Washington 1966).

of them will have to be considered in detail in the second phase, when total employment is distributed by occupation. Two ancillary research procedures must also be undertaken:

a. The first of these is to make as detailed an analysis as possible of the foreign references. Information is generally available on the average productivity levels of industries in which the structure of production is, in some cases, quite heterogeneous.

If all manufacturing industries are considered as a single division, reference to the international classification of economic activities will show that this division comprises twenty sub-divisions ("major groups"). The average productivity level of manufacturing in a country is heterogeneous and much influenced by the structure of production; it covers sub-division productivities which differ substantially, some being high, others low. For this reason the distribution of manufacturing by major group in the reference countries must be known. The productivity of a manufacturing sector which includes a large motor vehicle industry cannot be compared with that of a sector in which textile manufacture is predominant. The textile industry itself, however, includes activities as disparate as spinning, weaving and rope-making; machinery manufacture is divided into many branches specializing in very different types of product. The structure of an industrial sector in any country is peculiar to that country. Again, productivity levels can vary significantly according to the nature of the production process. Productivity is not the same in spinning and weaving factories. The first criterion for the choice of foreign references must be the structure of production in each industry, so that this structure in the countries used as examples may resemble that of the subject country as closely as possible.

An unduly wide disparity between the production structures of the country to which the projection is to apply and the foreign references should cause the choice of references to be revised and countries to be chosen whose productivity levels are not as similar as those used initially to the levels of the subject country but which, on the other hand, have a production structure resembling that of the subject country;

b. The second ancillary research procedure is concerned with prospects for change in industrial structures. There are a number of questions to be asked: is an entirely new industry to be established — for example, is a chemical industry to be set up in a country in which no chemical enterprise exists at present? If so, the new industry will be composed entirely of modern — and therefore homogeneous — enterprises. To use as a reference a foreign country all of whose enterprises are modern is justifiable, but the situation is quite unusual. Generally the production of an industry expands through the establishment of new enterprises which supplement those that already exist. Some of these older enterprises will be modernized, and the structure of the industry will therefore be a composite one. It will include enterprises operating at different technical levels and therefore with different

employment structures. In such cases, the productivity level calculated for the industry as a whole is an average of the high productivities of the new enterprises, the low productivities of the old ones and the productivities of the modernized enterprises.

To use as a reference a foreign country whose productivity level is comparable to that of the subject country may mean that the future occupational structure of employment in the latter country is not adequately allowed for. If the country selected has long been industrialized, the range of productivity levels among enterprises will probably be quite narrow, whereas it may be very wide in a developing country. A broad judgement must therefore be made on how the anticipated expansion of production will be achieved: by establishing new enterprises or by modernizing the old. The computations involved would be very complicated in countries which have long been industrialized and in which the number of enterprises in each industry is very high, but they are less difficult in developing countries in which the number of enterprises will still be fairly limited ten years from now.

The inadequacy of the statistical documentation available makes this method difficult to apply: the choice lies between identifying countries whose productivity levels seem to be closest to those sought, when detailed study of the structure of the industry in the countries selected is made, or using international documentation on productivity levels by industry for a large number of countries. There are at present only two sources for this type of documentation: the series of studies made by the Organisation for Economic Co-operation and Development (OECD) in connexion with the Mediterranean Regional Project, together with an OECD case study of Argentina³² and the treatise by Horowitz, Zymelman and Herrnstadt, which covers nineteen countries.³³ If these international data are used, there will have to be further research in the form of analyses of the structure of production and of the range of productivity levels among enterprises in the industries concerned.

There is one further difficulty. The process of international comparison requires productivity levels to be expressed in monetary terms. Productivity is measured by the value added per employee, expressed in United States dollars. The use of this method therefore demands that a prior estimate be made of value added for the final year of the projection. Value added does not, of course, depend solely on the technology used: it is also influenced by the position of the enterprises on the domestic and world markets, the Government's fiscal and subsidy policies, and the dynamism and intellectual capacity of the skilled personnel employed. A high

³² Organisation for Economic Co-operation and Development (OECD), *Country Reports: Spain; Greece; Italy; Portugal; Turkey; Yugoslavia* (Paris, 1965); and OECD, *Education, Human Resources and Development in Argentina* (Paris, 1967).

³³ M. A. Horowitz, M. Zymelman and I. L. Herrnstadt, *Manpower Requirements for Planning: an International Comparison Approach* (Boston, Northeastern University, 1966), vols. I and II.

productivity level per employee may be the result of high prices or low taxes or of a very enterprising management, technical department or commercial department. Lastly, the fact that value added is calculated in United States dollars means that the exchange rates used do not always reflect the true economic situation. The arbitrary exchange rates applied by certain countries cause the value of their productivity, as expressed in dollars, to be misrepresented.

(iii) Some reference must be made to a method of calculating productivity levels which is both briefer and cruder than those described above. The method links productivity to the level of production. P. Verdoorn has shown that over long periods there is a stable relationship between the trend of production and the productivity trend.³⁴

(c) *Examples of aggregate employment projections derived from estimates of future output and productivity; the value of these projections*

This method of projecting aggregate industrial employment has been used in many countries. For industry as a whole, the results are good in countries in which statistical data are adequate and the quality of economic forecasting satisfactory. In the USSR, for example, the growth in gross industrial output in 1955-1960 was higher than that projected: 85 per cent against 75 per cent; labour productivity per man-hour, which had been expected to increase by 50 per cent, in fact rose by 49 per cent. The discrepancy in the case of numbers employed was that the final figure was only 4.5 per cent higher than that projected; for 1960-1965, the results are better: actual numbers employed were 2.5 per cent higher than those projected.³⁵

In France the projections made for the industrial sector for the period of the fourth Plan (1959-1965) were fulfilled during the execution of the Plan. Industrial production was 1.5 per cent higher than that projected. The increase in productivity per man-hour met the Plan's targets.³⁶ On the other hand, there were some substantial discrepancies between the projections for individual industries and actual developments. Table 30 gives the relevant data on the execution of the French Fourth Plan for twenty-three industries. The output and productivity projections were both correct for only four out of twenty-three industries. In six, productivity increased less than had been projected but output also fell below the Plan's targets by roughly the same amount as productivity. In this case it seems likely that the difference between projection and result is not due to an error in computing the growth rate of productivity, but to failure to achieve the Plan's targets. In one industry — construction materials — output and

productivity were considerably higher than had been projected. In the case of twelve others, it is admitted that both production and productivity computations were incorrect.

These examples show the need to prepare variants.

(d) *Calculation of variants*

Two methods may be used: in one alternative assumptions are made concerning the output and productivity of each industry; the purpose of the other is to estimate the incidence on numbers employed of a change in the assumptions:

(i) The first method has been applied to Argentina.³⁷ Two productivity assumptions were used to project average annual growth rates of productivity of 2.53 per cent and 2.85 per cent. The level of output was the same in both cases. The resulting estimates of aggregate employment in 1980 were 11,160,000 in the first case and 10,495,000 in the second. These figures were compatible with two estimates of activity rates for the Argentine population — one assuming high activity rates and the other low rates.

From these two assumptions, which were treated as applicable to the economy as a whole, the growth in productivity in each industrial division was calculated. The estimates differed substantially. Whereas the average growth of productivity for the economy as a whole yielded by assumption II was 12.6 per cent higher than that yielded by assumption I, the difference was 36.2 per cent in mining, 47.3 per cent in construction and only 6.4 per cent in manufacturing. The difference in the growth rates of productivity from one assumption to the other is therefore not proportional to the growth in the average rate. Consequently, the estimates of numbers employed for a given level of output fall within a range which varies from one division of industry to another. The authors of the OECD report concluded that the theoretically possible changes in the pattern of productivity were sizable in some divisions, but slight in others. This conclusion is based on a detailed study of the present situation in industry in Argentina and its prospects (see table 31);

(ii) Another method may be used: sensitivity testing. It consists of systematically varying the assumptions for the average annual rates of growth of output and productivity, upward and downward, by one percentage point and computing the effect on the numbers employed in the industry.

The example given relates to the machinery and electrical appliances industry in France between 1959 and 1965. A complete set of ancillary assumptions was applied and the results compared with the observed growth of employment in the industry during the period (see table 32).

The calculations set out in table 32 may seem very complex since they introduce six ancillary assumptions.

³⁴ P. Verdoorn, "Complementarity and Long-range Projections", *Econometrica*, October 1956, pp. 429-450.

³⁵ United Nations Educational, Scientific and Cultural Organization, International Institute for Educational Planning, *Educational Planning in the USSR* (Paris, 1968), p. 90.

³⁶ France, Commissariat général du Plan d'équipement et de la productivité, *Exécution du Plan en 1965 et 1966* (Paris, Imprimerie nationale, 1966).

³⁷ Organisation for Economic Co-operation and Development, *Education, Human Resources and Development in Argentina* (Paris, 1967), chapter XX.

In fact, if the effects on the level of employment are examined, they may be reduced to two. In the example, instead of remaining at 380,000, the numbers employed ranged from 362,000 to 406,000, i.e., an increase in the range 23.5-38.5 per cent. In fact, the observed figure was 400,000.

This method seems particularly useful in cases where great uncertainty prevails as to the future trend of output and productivity, and the situation may develop in any of a number of ways. It shows the range within which the numbers employed may evolve. The ancillary assumptions, if they are applied uniformly to all divisions of industry, will, in effect, reduce or increase the aggregate level of industrial output by one percentage point. A useful purpose is served by studying such possibilities but, if the method is applied systematically to all divisions of industry, the assumptions obviously affect the aggregate level of employment, either by

significantly reducing it and thus creating an unemployment problem, or by increasing it to the point at which the necessary labour supply is unlikely to be obtainable. In this event the method amounts to formulating quite definite variants; it is, in essence, the same as the preceding method, but less flexible.

(e) *Allowing for possible changes in the length of the working week*

The methods of estimating labour productivity described earlier are applied without considering whether they are based on productivity per worker or productivity per man-hour. In fact, the estimation process is the same unless changes in the length of the working week are anticipated. If such changes have to be allowed for, the two concepts have to be separated and an additional calculation made to take account of the incidence of the reduced hours of work.

TABLE 30
Projected and observed levels of output, productivity and employment by industry, France,
1959-1965 ^a

Industry	Annual Growth Rates					
	Output		Productivity		Employment	
	Observed 1959-1965	Projected 1959-1965	Observed 1959-1965	Projected 1959-1965	Observed 1959-1965	Projected 1959-1965
02 Agricultural production and food manufacture	3.9	4.3	4.3	3.9	-0.4	+0.3
03A Solid mineral fuels	-1.5	-1.8	2.2	2.2	-3.8	-4.0
03B Gas	8.9	7.2	7.8	7.3	1.0	2.6
04 Electricity, water and others . .		(9.6)				
05 Petroleum, natural gas and motor fuels		10.4				
06A Construction materials	8.1	5.4	7.7	5.1	0.5	0.3
06B Glass	8.4	6.7	5.1	6.0	3.1	0.7
07 Iron ores and iron and steel products	4.2	6.3	3.5	4.3	0.6	1.9
08 Non-ferrous ores and metals . .	6.3	7.7	4.5	7.1	1.7	0.7
09A Products of basic metal industries and fabricated metal products .	4.8	5.7	3.2	4.7	1.5	1.0
09B Machines and mechanical appa- ratus	6.2	7.0	7.2	5.1	1.9	1.8
09C Electrical machinery and appa- ratus	9.7	10.2	4.2	5.6	5.2	4.5
09D Motor vehicles and cycles . . .	5.0	5.8	3.1	4.8	1.8	1.0
09E Shipbuilding, aircraft manufac- ture and armaments	5.0	0.7	3.8	2.4	1.2	-1.6
10 Products of the chemical and rubber industries	9.15	7.8	6.5	6.4	2.5	1.3
11A Textiles	4.3	4.6	5.3	5.2	-1.0	-0.7
11B Wearing apparel	4.0	5.4	5.0	5.4	-0.9	0
11C Leather	2.9	3.5	3.7	4.3	-0.8	-0.9
12A Products of the timber industry .	4.2	4.9	4.0	5.2	0.2	-0.3
12B Pulp, paper and paperboard . .	6.9	6.8	4.8	5.2	2.1	1.6
12C Printing and publishing	5.8	6.1	2.8	4.6	2.9	1.5
12D Manufacture of plastic products transformation and other indus- trial products	9.2	9.2	6.4	5.2	2.7	3.5
13 Construction and public works .	8.3	6.5	4.5	5.1	3.6	1.3

^a Percentages.

TABLE 31
Output, productivity and employment by major division of economic activity, Argentina,
1947-1980

	Growth 1950-1960 (percentage)	Level ^a in 1960	Assumption I		Assumption II		Difference between the rates of growth of productivity yielded by assumptions I and II (percentage)
			Annual growth 1960-1980 (percentage)	Level ^a in 1980	Annual growth 1960-1980 (percentage)	Level ^a in 1980	
<i>Mining and quar- rying</i>							
Output	10.8	11.8	8	55.2	8	55.2	
Employment . .	3	44.6	5	118.3	3.9	96.2	
Productivity . .	7.6	265	2.9	467	3.95	574	+36.2
<i>Manufacturing</i>							
Output	3.7	342.8	5.6	1,018.1	5.6	1,018.1	
Employment . .	2.1	2,145.6	2.4	3,450.3	2.2	3,329.8	
Productivity . .	1.6	160	3.1	295	3.3	306	+6.4
<i>Construction</i>							
Output	1.1	44.3	4.3	103.3	4.3	103.3	
Employment . .	-0.2	448.4	2.4	710.2	1.5	597.5	
Productivity . .	1.3	99	1.9	145	2.8	173	+47.3
<i>Electricity, gas and water</i>							
Output	6.6	13.8	8.35	68.7	8.35	68.7	
Employment . .	2.95	65.1	4.3	151.1	3.2	122.2	
Productivity . .	3.5	212	3.9	455	5	562	+28.2
<i>Total</i>							
Output	2.9	985	4.45	2,355	4.45	2,355	
Employment . .	1.25	7,680.1	1.9	11,160	1.6	10,495	
Productivity . .	1.65	128	2.53	211	2.85	224	+12.6

Source: Organisation for Economic Co-operation and Development, *Education, Human Resources and Development in Argentina* (Paris, 1967).

^a Output in thousands of millions of 1960 pesos; employment in thousands; productivity in thousands of millions of 1960 pesos.

The simplest solution is to assume that a reduction of 1 per cent in hours of work causes a fall of 1 per cent in output and an increase of 1 per cent in labour demand in order to offset the fall in output. This method is used in the Soviet Union.³⁸ Studies carried out in France in connexion with the preparation of the Fifth Plan have shown that the effects of a reduction in weekly or daily hours of work on labour demand are not, in fact, quite so marked as this. A reduction of 1 per cent in hours of work leads to a fall of only 0.6 per cent in output. Additional labour demand is therefore only 0.6 per cent of the working hours lost.³⁹

³⁸ United Nations Educational, Scientific and Cultural Organization, International Institute for Educational Planning, *Educational planning in the USSR* (Paris, 1967), pp. 89-90.

³⁹ France, *Commissariat général du Plan d'équipement et de la productivité, Rapport général de la Commission de la main-d'œuvre pour le V^e Plan* (Paris, La documentation française, 1966), pp. 361-393.

2. Distribution by occupation of total employment in each division of industry

Workers of many different occupations are employed in every industry. The main categories are: engineers, technicians, administrative staff, employees, and manual workers. Each of these groups, in turn, is heterogeneous. The textile industry, for example, employs not only skilled textile workers, but also mechanics, electricians and chemical workers. A mere knowledge of the level of total employment is, therefore, not sufficient. Employment must be distributed by occupation or at least by occupational group. There has been a great deal of research on this subject and five acceptable methods are available. A summary of their main features follows:

In the method of "the continuation of past trends" it is assumed that the recent observed pattern of change in the occupational structure of employment in each division of industry will be maintained in future years.

TABLE 32

Example of sensitivity testing applied to the machinery and electrical appliances industry in France for the period 1959-1965

		<i>As projected in the 4th Plan</i>	<i>Ancillary assumptions ^a</i>						<i>Observed growth</i>
Average annual rate of growth (percentage) . . .			A ₁	A ₂	A ₃	A ₄	A ₅	A ₆	
Output	10.2	10.2	10.2	9.2	11.2	9.2	11.2	11.2	9.7
Productivity . . .	5.6	4.6	6.6	5.6	5.6	4.6	6.6	6.6	4.2
Employment . . .	4.5	5.6	3.6	3.6	5.6	4.6	4.6	4.6	5.4
Numbers employed in 1965 (in thousands) . .	380	406	362	362	406	380	380	380	400
Increase over num- bers employed in 1959	+30	+38.5	+23.5	+23.5	+38.5	+30	+30	+30	+35

^a Explanation of symbols:

A₁ : annual growth rate of productivity minus one percentage point

A₂ : annual growth rate of productivity plus one percentage point

A₃ : annual growth rate of output minus one percentage point

A₄ : annual growth rate of output plus one percentage point

A₅ : annual growth rates of productivity and output reduced by one percentage point each

A₆ : annual growth rates of productivity and output increased by one percentage point each

For example, the percentage of engineers and technicians among total staff employed in each industry will continue to increase at the same rate as in the past period. This method is a projection technique rather than a forecasting technique.

The method of surveys at enterprises makes it possible to project employment by occupation within individual industries. Each of a representative sample of enterprises is asked to indicate its future labour requirements by occupation, for given levels of growth in output, productivity and total employment, these levels being a working hypothesis and based on prior estimates. This method, in effect, entrusts the analysis of changes in the occupational structure of employment to a group of enterprises considered to be better-informed on probable trends than a team of economists working at the national level. The procedure undoubtedly enables advantage to be taken of the experience of a large number of heads of enterprises, but it does not exclude arbitrary or ill-considered replies and provides no means of detecting them.

A third method consists of analysing the employment structure in the most modern enterprises in the industry. These provide a model for the distribution of employment by occupation that will prevail throughout the industry in some years' time when the new production techniques being applied in the most advanced enterprises have been adopted by the others. A variant of this method is to formulate theoretical norms for employment by occupation in a typical factory in the industry. It is assumed that enterprises set up or modernized in the future will apply this theoretical pattern of employment.

The method of applying models of employment struc-

tures in foreign countries with a higher level of economic development than the countries studied may also be used. The reasoning process is the same as in the case of the projection techniques just described, except that the comparison is of divisions of industry having the same type of production and not of enterprises engaged in the same type of economic activity.

Lastly, future labour demand in certain occupations can be projected by linking it directly to future output wherever adequate reliable statistical data exist. It is assumed, for example, that the number of engineers employed varies in proportion to the growth in output. The principle of this method is the same as that formulated by P. Verdoorn; two working hypotheses are used: that increased output is linked to increased productivity, and that the increase in the number of engineers and the increase in productivity are closely correlated.

All these methods except the last have been the subject of many applications. None has given complete satisfaction, perhaps because the necessary statistical documentation cannot be obtained, because the systematic nature of the method proves to be a serious obstacle, or because additional analyses are found to be necessary. As matters stand, it seems that only a combination of methods will yield valid projections by occupation. Since the techniques employed are not the same for a developing country as for a country long industrialized, the two cases will be treated separately.

(a) *Developing countries*

As in the case of the calculation of productivity levels, extrapolation of past trends cannot be used in making projections of employment by occupation, since the necessary statistical data generally do not

exist or, where they do, are useless for the purpose. There is a general desire in developing countries to industrialize as quickly as possible and to alter the previous observed trend of industrialization. Extrapolation of the past trend of the distribution of the economically active population by industrial occupation merely projects into the future an unduly slow rate of industrialization which clearly needs to be altered. Surveys at enterprises cannot be used for this purpose. The future development of industry hinges on the establishment of many new enterprises or on the complete modernization of old ones. The questioning of existing enterprises on their labour requirements is pointless.

The use of models of employment structures in foreign countries with a higher degree of industrialization is undoubtedly the best method. Moreover, this method is one of the few that can be used in the case of countries whose statistical data on the distribution by occupation of the economically active population is poor. The basic principle of the method is that for each level of productivity there is a corresponding occupational structure of employment. Given this level, the employment structure can be deduced. Then this structure can be applied to the figure for aggregate employment, calculated according to methods described earlier, in order to obtain the distribution by occupation. This, in fact, amounts to a more elaborate version of the basic (Cobb-Douglas) production function, which becomes: $Q = F_1(K, L_1, L_2, \dots, L_n)$, in which L_1, L_2, \dots, L_n represent workers whose skill or occupation — depending on the purpose of the classification — is at levels 1, 2... n . On introducing the total labour force (L) the equation becomes: $Q/L = F_2(K/L, L_1/L, L_2/L, \dots, L_n/L)$. Moreover, if it is assumed that K/L , i.e., capital per worker, is linked to labour force composition, the following equation is obtained: $Q/L = F_3(L_1/L, L_2/L, \dots, L_n/L)$. If the principle of these equations is accepted, the desired result can be obtained by calculating the employment structure corresponding to productivity level chosen.

In practice this method is more complex; it must be used with great caution and demands analyses in greater detail than any so far made. Recourse to the other methods described in the introduction — theoretical employment norms, correlation between the future trend of output and the demand for certain categories of labour — can usefully supplement the calculations made on the basis of foreign models.

(i) Principle of the method

A considerable volume of international statistical data is required to determine these employment structures. Examples drawn from a small number of countries will not suffice. The establishment of a reliable statistical series demands comprehensive observations from countries whose levels of economic development are as varied as possible. Few examples of a complete distribution of employment by occupation and by industry are available at present. Their preparation presupposes not only that there should be data available on the distribution of the economically active population by

sector of economic activity and by occupation, but also that these data can be cross-tabulated. Population censuses are the usual means of securing this data. However, although there is always a distribution of the economically active population by sector of economic activity, not all censuses provide accurate information on occupations and few make provision in their census programmes for a cross-classification of the economically active population under these two headings; such tabulations are generally available only for the most advanced countries.

The principal source of information available is the study by Horowitz, Zymelman and Herrnstadt.⁴⁰ The authors analyse the occupational composition of employment in all sectors of the economy in 19 countries; they enumerate 58 sectors, 35 of them in industry proper, and 225 occupations in 7 major groups. In principle, the distribution of employment among these 225 occupations in each of the 58 sectors is given for one year, or for two years in the case of 7 countries. The productivity level is measured in each case by "value added per worker" expressed in United States dollars. Unfortunately, for the reasons given earlier, this data relates mainly to countries which have long been industrialized.

The OECD Mediterranean Regional Project and the OECD study on Argentina provide models which are more useful for developing countries, inasmuch as the structures in Spain, Greece or Portugal more closely resemble their own, but an accurate distribution of employment by occupation was hard to establish for these countries. Since the issue of those reports OECD has published a detailed study of the occupational and educational structure of the labour force in fifty-three countries.⁴¹

All this material on occupational distribution within individual industries and the corresponding productivity levels makes it possible to consider in some detail the practicability of using a method of projecting employment based on the use of foreign references. Horowitz, Zymelman and Herrnstadt, for example, studied two types of equations, the first being linear and in the form:

$$y = a + b_{11}x_{11} + b_{21}x_{21} + \dots + b_{n1}x_{n1},$$

in which y = productivity and $x_{11} \dots x_{n1}$ are the proportions of occupations 1... n in the labour force of industry 1; the second is non-linear (log function) and of the form:

$$\log y = a + b_{11}\log x_{11} + b_{21}\log x_{21} + \dots + b_{n1}\log x_{n1}.$$

The resulting multiple regression equations indicate that there is a correlation between productivity and occupational structure for some groups of occupations and that variations in the proportion of professional and technical workers are a major determinant of productivity in most industries.

⁴⁰ Horowitz, Zymelman and Herrnstadt, op. cit.

⁴¹ Organisation for Economic Co-operation and Development, *Statistics of the Occupational and Educational Structure of the Labour Force in 53 Countries* (Paris, 1969).

The influence of clerical workers, on the other hand, is at most marginal. The coefficients of correlation were rarely below .63 for professional and technical workers: only the machinery industry fell below this level. They were in some instances as high as .9 — in printing and publishing, glass products, and stone and clay products. The coefficients were in all cases significant at the 95 or 99 per cent level. These results are those yielded by the linear functions, but a substantially similar result emerges from the analysis of the log functions. However, the standard deviations in the resulting parameters are occasionally large, as in the case of textiles, furnishing and electrical machinery. The OECD analyses went into much greater detail, a number of different approaches being applied in turn.⁴² The main conclusion is that there is a relationship only at a highly aggregated level between productivity and a limited number of variables representing fairly wide categories of workers.

This data can be used in two ways:

a. If the coefficients of correlation are valid for some occupations, the regression equation gives the proportion of all workers employed in these occupations at a given level of productivity. The OECD study on Argentina used this method. For example, according to the regression equation, the productivity level in mining in 1980 will require 5.3 per cent professional and technical workers and 3.5 per cent managers among all labour employed;

b. If the coefficients of correlation are unhelpful, the data on the occupational structure of employment may still be used. This second method is less demanding. It takes into account only the occupational structures of the country or countries in which the productivity level of the industry concerned is nearest to that selected as a target. The aim of the exercise is to determine what requirements would have to be met if the model employment structures were imitated.

This is how Horowitz, Zymelman and Herrnsstadt suggest using the international statistical data which they have collected. The example they use is the textile mill products industry. If, in the country which is the subject of the forecast, the value added per worker is assumed to be \$US 2,000 in 1975, their study gives the productivity levels and employment structure of the textile industry in all the countries covered. It indicates that the anticipated productivity level is near that of Denmark in 1950 (\$2,130), Argentina in 1960 (\$2,160), Chile in 1960 (\$2,000) and Ireland in 1960 (\$1,800). It is, therefore, these countries' occupational structure of employment that must be taken into account.

Table 33 gives the distribution by occupation of the workers employed in the textile industry in these four countries. Variations in structure are slight for the major occupational groups; in the case of an important group, scientific, professional and technical workers,

Chile is exceptional in having a percentage twice as high as the three other countries. However, there are substantial differences within the major groups, as in the case of the manual workers group. Different classification methods cause some of these differences: all manual workers in Denmark were classified under the heading of "Other manual workers"; in Ireland some workers were classified as labourers. Some groups have the same classification in all four countries; this applies to most manual occupations other than those of textile workers. In general, the table indicates that the figures for each country can be explained by a study of its statistics, industrial structures and employment situation.

This method gives a very clear illustration of the practical difficulties that are encountered in utilizing the employment structures of foreign countries. They include differences in the way the labour force is classified, the peculiarities of the employment structures of the country, arising out of its traditions, and differences in the nature of production, as reflected by the occupational distribution of employment and the number of small or medium-sized enterprises in the industry.

For these reasons, the two methods described are complementary. The first yields a distribution by major occupational group, based on the significance of the correlations observed among a fairly large number of countries. The second permits a more detailed occupational breakdown to be made, but in many cases it merely serves to indicate what the obstacles to international comparisons are and which specific problems should be studied. Accordingly, international comparison is an essential part of projecting employment by occupation, but one which can be satisfactorily performed only if very thorough analyses are undertaken.

(ii) *Other comparisons*

a. *Difficulties*

Some of the difficulties encountered are the same as those mentioned earlier in this chapter in connexion with the choice of model productivity levels from foreign countries. The heterogeneous nature of production in such an important industry as the textile industry is one of them, and there are others.

Firstly, the distribution of output among the industry's main types of production must be determined. This can usually be done fairly easily, at least in an approximate fashion, on the basis of the preparatory planning document or of research on the future trend of output. The resulting distribution by minor group must be compared with that observed in the foreign country whose employment structure is being used as a reference. If the types of distribution are very different, the foreign references are of very little use. There can be no valid comparison between the employment structure of a textile industry in which the share of cotton is 80 per cent and that of an industry based mainly on synthetic textiles, even if the levels of productivity — future in one case and observed in the other — happen to be the same. The distribution by occupation will necessarily differ.

⁴² Organisation for Economic Co-operation and Development, *Occupational and Educational Structures of the Labour Force and Levels of Economic Development; Possibilities and Limitation of International Comparison Approach*.

If no detailed analysis is possible — either because the national planning projection for the industry is not sufficiently detailed or because the documentation available concerning the foreign countries does not provide the necessary data — it will clearly be impossible to make occupational projections in any form more refined than a distribution among five or six major

groups of occupation: engineers and technicians, manual workers, clerical workers and so forth. That will be so, for instance, when employment projections have to be made, for lack of precise information on future production trends in the country which is the subject of the projection, for all manufacturing industries. A group such as this is too heterogeneous to

TABLE 33
Structure of employment by occupation in the textile industry
in Denmark, in Argentina, in Chile and in Ireland

	Denmark 1950	Argentina 1960	Chile 1960	Ireland 1960
	(per 1,000 workers)			
Scientific, technical, professional and related workers:	9	8	20	6
Accountants		2	5	
Engineers	6	4	2	
Technicians	3		12	
Miscellaneous				6
Managers and administrators:	33	36	35	21
Working proprietors	28	3		
Employed managers	5		35	21
Others		32		
Clerical and related workers:	36	67	63	56
Bookkeepers and cashiers		8	5	
Secretaries and typists		1	7	17
Other clerical workers (not classified elsewhere)	35	55	50	39
Sales workers, including:	14	14	4	9
Representatives	6	11	3	8
Manual workers, including:	901	863	856	871
Foremen, supervisors, inspectors	54			59
Textile workers, including:	2	724	702	528
Fibre preparers			19	22
Spinners and winders			88	94
Weavers and related workers			541	140
Knitters and hosiery workers				125
Bleachers and dyers	2		23	29
Other textile workers		724	31	118
Clothing and related workers, including:	97	20	24	67
Tailors	86			
Other clothing workers	11	20	24	63
Wood workers		6		23
Construction workers, including:		13	21	3
Carpenters			11	2
Electricians		4	6	1
Plumbers and related workers		6	2	
Transport workers	6	6	8	4
Mechanics and repairmen	7	36	62	18
Stationary engineers and firemen	5	24	8	2
Labourers	10	10	6	107
Other manual workers	720	9	2	51
All specialized service workers, including:	7	12	22	7
Protective service workers		4	5	
Service workers	7	4	15	4
Other workers				30
TOTAL	1,000	1,000	1,000	1,000

Source: M. A. Horowitz, M. Zymelman and I. L. Herrnsstadt, *Manpower Requirements for Planning; an International Comparison Approach* (Boston, Northeastern University, 1966). Vol. II, pp. 80-81.

be the subject of a detailed projection of occupational employment. Even at this high level of aggregation, the errors are likely to be high and it would be desirable to have at least several occupational sub-divisions.

The second difficulty is due to the fact that the composition of any industry, by size and level of productivity of enterprises, differs from country to country. In most cases there is little information on this subject. It is almost always possible, however, to deduce from the statistical documentation of each of the foreign reference countries quantitative data on the number of enterprises in each industry and a qualitative judgement on the scatter of productivity levels i.e. information on the co-existence of very modern and quite old enterprises.

Here again, as in the case of productivity levels, the problem lies in the country which is the subject of the projection rather than in the foreign countries. It is there, where industry must develop rapidly by the creation of new firms, that the range of dispersion is likely to be greatest. A study of the present state of industry and its development pattern should make it possible to answer that question. If it appears likely that the industry in question will in future be composed solely of very modern enterprises, theoretical models can be used to distribute employment by occupation, provided that such models exist. An example of this type of work is provided by the studies issued by the United Nations Centre for Industrial Development, which assessed the manpower needs by occupation of a number of industries. For the sugar industry, for example, an experimental assessment was made for various types of factory producing from 1,000 to 10,000 tons a day, a distinction being made depending on whether the production unit was very modern or of long standing.⁴³ These theoretical models are very useful to developing countries which possess sufficiently accurate information on the new factory openings planned for future years.

If it seems that several types of enterprise — modern and otherwise — will exist side by side in the industry at the end of the projection period, two occupational distributions of employment may be used, each corresponding to a separate range of productivity levels within the industry: one distribution will be based on that of a reference country with a high level of productivity or on theoretical norms of employment structure, and the other will apply to enterprises with a low level of productivity; in the latter case the reference will be to developing countries similar to or slightly more advanced than the one being studied and there will be no reference to a foreign country as a model for the average level of productivity.

These analyses, which would be a very complicated operation in the case of an economy which has long been industrialized, are not necessarily so difficult in a developing country, in which the number of industrial

enterprises will, in any case, still be relatively small in ten years time.

b. *Structure of employment, output and productivity*

The occupational distribution of employment within each industry, determined in the manner just described, reflects the labour demand generated by a desire to attain planned output targets and selected levels of productivity. But is there only one employment structure which corresponds to the economic and technical goals so selected? Are there not several possible employment structures which would make it possible to attain the same results in output and productivity?

An analysis of the statistical data of foreign countries of a comparable level shows that this is a legitimate question. In the textile industry, as noted earlier, the distribution by occupation in four countries with comparable levels of productivity differed quite appreciably.⁴⁴ Do specified levels of output and productivity necessarily entail a specific occupational structure of employment? This was the working hypothesis adopted at the beginning of this discussion but it must be challenged, now that the research has been done. Are some substitutions not possible among occupations, say, engineers and technicians?

Consideration of this problem is made very difficult by the absence of statistical information which can easily be interpreted. Hollister pointed out that the proportion of technicians and similar workers among all workers in the manufacturing industries in Spain, Greece, Italy and Portugal was roughly 3.5, 7 and 17 in the base year for the OECD studies.⁴⁵ There are many possible reasons for such discrepancies: manufacturing covers very disparate and very numerous industries, each of which has its own employment structure, and the distribution of these industries within the manufacturing group varies considerably from country to country; some of them are not represented, as is the case with the motor vehicle industry in Portugal and Greece, and the employment classifications are not homogeneous. If homogeneous sectors of production having the same system of occupational classification were compared, the differences in employment structures would most certainly be greatly reduced.

Although analysis cannot be pushed very far at the level of statistical fact, the problem can be clearly stated at the theoretical level. The series of estimates proposed as a means of distributing aggregate employment by occupation is part of a first approximation derived from an analysis of international data classified by levels of productivity. That approximation was subsequently corrected to take account of the specific characteristics of the industry in the country studied: probable composition of output, dispersion of productivity levels, distribution by size of enterprise. One further correction remains to be made.

There is undoubtedly a close connexion between

⁴³ United Nations, Centre for Industrial Development, "A report on the world sugar industry: managerial and technical personnel requirements" (CID/VI/Background Paper No. 19, April 1966).

⁴⁴ See table 33.

⁴⁵ Organisation for Economic Co-operation and Development, *A Technical Evaluation of the First Stage of the Mediterranean Regional Project* (Paris, 1966), pp. 34-40.

productivity and occupational structure. Opportunities for substitution are fairly limited. The same output can probably be achieved with fewer technicians and a slightly larger number of manual workers, but then the figure for productivity per worker is altered, as the number of extra manual workers is always higher than the number of technician's jobs eliminated. On the other hand, functions requiring a high level of skill can be assigned to workers of slightly different ranks and belonging to different occupations. What the production techniques prescribe are technical functions and these can be allocated in different ways at the place of work. In a country which has few engineers, the maximum number of technical functions will be assigned to technicians, who will be working at the very limit of their knowledge and abilities. In a country which has an abundance of engineers, the distortion will occur in the opposite direction.

Is it reasonable to assume that in a developing country the proportion of engineers will be as high as that in the long-industrialized countries whose levels of productivity have been used as a reference? One may well doubt it. The same applies at the level of technicians and that of skilled workers. Variants assuming slightly lower proportions for those occupational categories can be established to take account of such situations. Here again there is a distinction to be made between employment projections which reflect targets to be attained (first estimation) and estimates of probable employment trends (second estimation).

In some cases, an analysis of the practical prospects for the recruitment of qualified personnel may lead to the adoption of a much higher assumption than that used originally for manpower at this level. But an adjustment of this kind necessitates a review of the levels of productivity selected and means beginning the whole projection operation again from the point at which a fixed productivity figure was incorporated. What this comparison demonstrates, in fact, is that the productivity figures selected cannot be attained because of the lack of the necessary skilled personnel.

(iii) *Concluding observations*

The projecting of occupational employment in industry and construction undoubtedly ought to be done in two stages, the first being an estimate of total employment and the second a distribution by occupation. This distinction is partly artificial, however. The distribution by occupation may cause the levels of output and productivity adopted, and consequently the total employment figure, to be revised. Employment projections are very closely associated with economic projections, but express in terms of manpower the economic choices made and may show their impracticability, as when, for example, the personnel required cannot be recruited. In this event the productivity projection, and possibly the whole economic projection process, must be done again, including, perhaps, a review of output targets. The analysis of labour demand may, in fact, show that these targets are unattainable.

Into how many divisions should industry and construction be classified? No single answer can be

given to that question but the following comments should be borne in mind. The classification into four major divisions — mining, manufacturing, construction, and gas, electricity and water services — is probably inadequate in one respect: the manufacturing industries represent a complex group, not easily analysed, and in the case of which the use of foreign references serves little purpose; the reasons for this were stated earlier in this chapter. It is desirable that this major division should be sub-divided as finely as possible, so as to distinguish minor groups whose production is broadly homogeneous and which can be compared with foreign minor groups having roughly similar production. This probably means jettisoning the possibility of using international statistical series covering many countries, but it is preferable in these circumstances to have the projection work done in two stages, as suggested earlier: first as complete a "fit" as possible is established with an international statistical series and then each minor group is studied in detail. Here it is best to have only one foreign country reference but to subject it to thorough analysis in order to eliminate those features of its employment structure which cannot, for one of the reasons mentioned above, be applied to a developing country. Accordingly, the largest possible number of minor groups should be distinguished, the only limiting factor being the need for sufficiently detailed economic projections on which to base output levels for each minor group.

On the other hand, the number of occupations to be distinguished in each division must be kept fairly small. The list of 225 occupations prepared by Horowitz, Zymelman and Herrnstadt would be impossible to use. The ten major groups of the ILO standard classification of occupations (ISCO) are admittedly too broad for the purpose but, on the other hand, the minor groups of this classification are suitable only for a limited number of occupations in each industry. In the textile industry, for instance, one might distinguish between textile workers proper and other manual workers. The minor groups will therefore not be the same within individual industries but the total number of occupations per industry should not exceed twenty; otherwise there will be too much detail. Beyond that figure, the imprecise nature of the method operates so as to jeopardize the validity of the results. No universally applicable figure can be given, because two factors must be taken into consideration: the industrial structure of the country, and the degree of detail in the planning projections of industrial production. In some countries, the industrial sector will have only a small number of groups, since only a few types of industry can be established in coming years. Other countries, of a higher economic level, may contemplate more complex forms of development. In the former case, the number of occupations will be very small; in the latter, it will necessarily be greater. The degree of detail in the planning projections of industrial production is also material. If there is inadequate detail on probable growth by industry, employment projections will necessarily be highly aggregated. If there is no specific projection for the textile industry, it is clearly impossible

to make employment projections for textile workers. Again, if the economic projections provide only an output target for all processing industries and this target cannot be distributed by minor groups, the employment projection can obviously cover only five or six occupational groups: engineers and technicians, managers of enterprises, clerical workers, manual workers, and service personnel, each of these categories being further classified into skilled and unskilled workers.

The method proposed in this manual is a heterogeneous one. It is based initially on econometric calculations, the results of which are corrected by reference to qualitative assessments. It is suggested that a number of variants be calculated. The various stages of the estimation process will be shown in the presentation of the results, since each stage has a special significance.

(b) *The developed countries*

The circumstances of the developed countries are entirely different: the statistical data are more abundant and economic development is a steadier process. There is therefore no need to begin by using a model foreign country of a higher economic level. In the first stage, the "continued past trends" method can be used; the first projection thus made will serve as a basis for subsequent corrections. This method of the projection of past trends has the merit of not raising the problem of the comparability of employment classifications; its drawback is that it does not take account of new factors which will affect the occupational structure of employment in future years; these factors will have to be introduced later. Surveys at enterprises and reference to a foreign country at a higher level of development may then be useful. They make it possible to correct the results of the first projections.

(i) *Continuation of past trends*

This method can be used only in countries which know how the distribution of employment within each industry has evolved during recent years, by fairly detailed occupational groups. When this is so a matrix model of employment by sector and occupation is available. In this matrix the vertical columns represent the structure of employment by occupation in each industry and the horizontal rows the distribution of occupations among the industries. From it one can ascertain, for example, the percentage of engineers among all workers employed in the electrical machinery industry for a given year and the distribution of all engineers employed in industry among the groups — electrical machinery, machinery, textiles. Usually, such matrices have to be prepared on the basis of population censuses which give information on the distribution of employment by occupation and by sector. If this matrix exists for only a single year — that of the last census, for example — its usefulness for projection work is limited. The occupational structure of employment observed for each industry at the date of the census can, of course, be applied to the estimate of total employment for the final year of the projection. This will yield a distribution by occupation of the total figure, but this procedure amounts to increasing the

numbers in each occupation by a percentage equal to the projected increase in total employment.

Such a method necessarily leads to incorrect results. The growth of total employment in an industry is always accompanied by a change in the structure of employment: new equipment is brought into service; productivity rises; the proportion of engineers and technicians tends to increase; the distribution of manual workers by occupation is also altered, as when the proportion of maintenance workers is increased; and, lastly, the skill level of production workers may be changed.

The procedure may, however, be valuable in the first phase of a projection. It provides a basis for a projection and not the projection itself. The effect of the over-all increase in numbers employed in an industry on the occupational distribution can be studied by this means, aside from any changes in the structure of employment — a question that can be dealt with in a subsequent phase, on the basis of data obtained by methods to be explained later.

When two or more matrices are available for successive years, the evolution of the employment structure of each industry in previous years can be studied. Trends become apparent which make it possible to work out, for example, the rate of growth in engineers employed when total employment in the industry increases by a specified percentage. If it is assumed that these ratios remain constant over time, the increase in the number of engineers in the industry for a given rise in total numbers employed can be calculated. This assumption is itself open to criticism. Is it true that when employment in an industry increases, the occupational structure of employment always changes in the same fashion and, if so, does the ratio between the total increase and the increase in a given occupation remain stable? This argument cannot be accepted.

Changes in the aggregate employment of an industry are related to the movement of output and of productivity. Rising productivity slows down growth in numbers employed. A changing structure of employment within an industry is undoubtedly linked with improved productivity: experience shows that the more productivity increases, the higher is the proportion of engineers and technicians among the total number employed. The correlation is not necessarily a close one, however; it may vary over time depending on the nature of the productivity improvements. The same observations may be applied to the reduction of the proportion of manual workers among all those employed and to the rise in their skill level. However, in a country in which industrial development is proceeding at a steady pace, this method can advantageously be used for a first projection of possible changes in the structure of employment.

These methods have been used in Japan.⁴⁶ Two computations were made of the occupational distribution of the economically active population in 1971 by applying to the projection of total employment by

⁴⁶ Japan, Economic Planning Agency, *Manpower Programme in Japan* (Tokyo, 1967).

industry, first, the structure of employment observed in 1965, and, second that resulting from an extrapolation of changes observed in the employment structure in 1960-1965. Discrepancies in the results are quite substantial: for scientific, technical and professional workers, for instance, the annual increase projected for 1965-1971 is 3.2 per cent in the first case and 4.1 per cent in the second. The annual reduction in the number of underground mine-workers was 4 per cent in the first case and 8.6 per cent in the second.

In France, a more complex method has been developed. Four assumptions as to possible structural changes in employment in 1962-1970 were used in turn with a view to identifying the ultimate limits of real change; the final assumption, however, is considered to represent the most probable pattern. They are: a "low" assumption, according to which there will be no change in the structure of employment in 1962-1970, the structure observed in 1962 being applied to the sectoral employment totals for 1970 in each sector; a "medium" assumption, which assumes a linear evolution during the next eight years of the changes observed in the structure of employment in 1954-1962; a "high" assumption, which allows for a rate of change in the structure of employment which is double that of the "medium" assumption; and an adjusted assumption — one which is corrected by data supplied by the Commissions for the Fifth Plan. This last assumption was regarded as the most probable one, but the existence of the other three indicates the range within which the real changes will occur.

However refined the techniques for the projection of observed past trends may be, they are obviously not capable of predicting deviations which will occur in future years and which will alter the patterns of change in employment structures observed in past years. They do not allow for new factors.

(ii) *The factors most likely to produce structural changes in employment in individual industries*

The intensity of utilization of personnel is the chief factor. At some time, enterprises may have a surplus of, for example, engineers, owing to heavy recruitment in earlier years. Bearing in mind the expected increase in requirements of highly skilled manpower in years to come, this surplus is temporary, but it will have a potentially strong effect on the evolution of demand for this category of personnel for some years to come.

Only by surveys at enterprises concerning the current employment situation can information on such under-employment situations be obtained. A review of recent developments in the length of the working week can also provide useful information, at least on the degree of utilization of production capacity and full employment among hourly-paid workers.

The evolution of the industry's capital equipment is another subject to be considered. It is the nature of its capital equipment, rather than the level of productivity — which is only a means of measuring the efficiency of that equipment — which governs the occupational distribution of employment. What new technical advances will be introduced in future years, and what

manpower needs will they create? In research recently carried out in the United States of America in connexion with the preparation of employment projections for 1975, particular attention was paid to these matters. To take one example, in the paper-making industry, anticipated technological innovations are indicative of further progress in continuous production processes and of faster machine output. This will have a dual effect on employment: employment of skilled manpower for machine maintenance will rise and the present number of production workers will fall. The development of centralized control systems and the use of computers to check continuous-process operations will increase the demand for computer engineers and technicians.

In the paperboard industry, occupations involving the making of cardboard boxes will disappear gradually with increasing mechanization. New requirements will, however, be generated by the development of techniques of printing on paperboard: printing workers will be needed.⁴⁷

The development of scientific research in each industry must also be the subject of specific study. Movement in the numbers recruited for this function is largely independent of productivity changes, at least for short-term and medium-term purposes. There is no association between such personnel and the nature of the industry's capital equipment. The latter factor does, however, determine the productivity trend. The recruitment of research personnel accordingly upsets the relationship between the occupational structure of employment and productivity. For this reason scientific research personnel must be excluded from the data concerning the employment structure and treated separately.

Changes in the distribution of enterprises by size are an important influence in altering employment structures. This observation applies primarily to industries in which the number of enterprises was formerly very high and in which there is a widespread movement towards concentration. The number of heads or managers of enterprises will fall, and it is important to estimate the extent of this decline. Changes in the size of enterprises affect other spheres, too, but their effect is uncertain and is dependent on that of possible mergers and concentration. Research on this subject should be undertaken in the case of industries in which the problem may become acute in future years.

The final factor to be studied is the anticipated output of young graduates and certificate-holders from educational establishments in order to judge whether new situations are likely to emerge on the labour market. If, for example, new types of training have been introduced in educational establishments, the entry to the labour market of young people who have received this new training changes the practices of the market. Enterprises may want to recruit these new workers,

⁴⁷ United States of America, Bureau of Labor Statistics, *America's Industrial and Occupational Manpower Requirements, 1964-1975* (Washington, D.C., 1966), pp. 38-40.

rather than those trained by the old methods or in preference to promoting serving staff who hold no diplomas but have sound career experience.

Methods which enable allowance to be made for these factors must therefore be used.

(iii) *Summary account of methods which can be used for ancillary estimates*

A brief description of these methods follows:

(a) The first method is that of using as references occupational employment structures selected from similar industries in foreign countries. The value of such references and the problems they involve have been explained in connexion with the study of the occupational distribution of aggregate employment in developing countries. The observations made then are valid also for developed countries.

(b) Surveys at enterprises are another method. The most sophisticated form of survey is the USSR method known as the "classified lists of posts".⁴⁸ All enterprises are asked to estimate their requirements of what are termed "specialists" for the following five years, "specialists" meaning all workers of whom secondary or higher education is demanded. A very detailed nomenclature of positions is established by the central authorities; for each post to be filled, the educational level — secondary or higher — and the speciality required must be stated. The enterprises must use this nomenclature in specifying their manpower requirements for the following year and for each year of the five-year Plan. They must include not only additional manpower needs but also replacement needs. In the case of enterprises established during the plan implementation period, this work is performed by the administrations establishing them.

The projections required of enterprises are therefore very detailed and are quite difficult to prepare for a five-year period. Enterprises can, of course, base their estimates on the very detailed projections of output and investment embodied in the five-year Plan. This presupposes detailed planning — a situation which does not apply in most countries. Even if it did, the projecting itself is still very difficult. The enterprises must imagine what effect changing production techniques will have on specialist requirements. They can, of course, refer to the experience of the most technically advanced enterprises, but they are not necessarily always aware of it.

Inevitably, the degree of judgement left to the management of each enterprise is very large. Some may overstate their requirements and others understate them through errors of judgement. A method of projecting employment based on such detailed surveys at enterprises has an arbitrary element in it, due to these errors of judgement. The method itself, however, makes no allowance for assessing the magnitude of such errors unless, as the USSR planners do, other methods are used to check the results.

⁴⁸ United Nations Educational, Scientific and Cultural Organization, International Institute for Educational Planning, *Educational Planning in the USSR* (Paris, 1967), pp. 139-145.

Nevertheless, while there are difficulties about leaving all projecting of manpower requirements to the judgement of enterprises, the surveys may provide valuable information on certain points, such as the degree of underemployment among certain categories of workers at a given date and the job intentions of young people with new types of training.

(c) Analysis of the employment structure in the most modern enterprises in the industry and the study of new techniques is a method which at first sight seems very satisfactory. The demands of economic development will cause enterprises using old methods to disappear or become modernized. The employment structures of the most technically advanced enterprises will gradually come to prevail throughout the industry.

In practice, however, there are a number of difficulties. Rarely is a single enterprise representative of the whole industry inasmuch as it produces all the product of the industry. But the structure of employment is related to the nature of the output; the single enterprise does not therefore provide a pattern for the future employment structure of the whole of the industry. Furthermore, progress is not limited to the mere extension of techniques already known to certain enterprises to all the firms in the group. Other technical advances will be introduced, which will be used, not only by the most modern enterprises making new investments, but also by enterprises having obsolete production techniques which modernize themselves all at once.

A more interesting approach is the study of new technology and its potential effect on employment. A great deal of research has been done on this subject in the United States of America. The example was given earlier of paperboard manufacture, as one of the new factors to be taken into consideration. The application of this method demands a thorough analysis of the production techniques which will be employed in future years and of the speed with which they will be disseminated. New investment projects for the industry must be taken into account and this is where the main difficulty lies, since the information available on the past rate of dissemination of new technology and on the factors which govern it is poor. New research should be undertaken in this matter.

C. PROJECTION METHODS IN THE SERVICES SECTOR

The services sector covers three divisions of the international classification of economic activities: commerce, which includes banks and insurance (division 6); transport and communication (division 7); and services, which includes public administration, community services, business services — accounting, legal services — and personal services, such as health and education — (division 8).⁴⁹ A common bond links these divisions: they provide services rather than

⁴⁹ *International Standard Industrial Classification of All Economic Activities* (United Nations publication, Sales No.: 58.XVII.7). (A revised edition was published in 1968; see United Nations publication, Sales No.: E.68.XVII.8.)

produce goods. Apart from this fundamental characteristic, this sector has other features which distinguish it quite clearly from both agriculture and industry. The methods of projecting employment will therefore be very different in most cases from those which have been proposed for those sectors. Two groups of methods, corresponding to two separate approaches, will be described: the analytical method and the aggregate method, both of which take account of the special problems which arise in studying employment in the services sector.

1. *Principal characteristics of the services sector*

These characteristics are:

(a) The influence of natural conditions and foreign trade is negligible. A country's agriculture is strong or weak according to the value of the arable land it possesses; the ease with which its industry can develop will depend on its power or raw materials resources. Accordingly, the development of these two sectors may differ greatly from one country to another. Foreign trade accentuates such discrepancies. Some countries have an important agricultural sector whose main justification is export. Countries which have an important industrial sector may also be in this situation. In such circumstances domestic consumption plays only a minor role in the expansion or decline of these activities. Throughout the services sector, however, such factors are of only secondary importance. There are undoubtedly countries which have a sizeable hotel industry as a result of the tourist value of their scenery; others are financial centres whose importance is out of all proportion to the country's level of economic development. These are exceptional cases, however, and relate to divisions of industry which are of relatively minor importance within the services sector. In the important branches of this sector — such as public administration, education, health services and personal services — the predominant factors are the size of the population and the level of national *per capita* income. This situation makes it possible to use methods of projecting employment based on the existence of correlations between the evolution of these basic data and employment;

(b) On the other hand, employment cannot, in the majority of cases, be calculated, by a process of deduction, from anticipated output and productivity, as is done in the case of industry. The concept of output can hardly be applied to the services sector.

Output cannot be estimated in physical quantities as it theoretically can in the case of agricultural or industrial products. An estimate in terms of value is the only means of determining the future level of output of the services sector. Here, output estimates are derived from the value of the services provided. For services which have a market value, such a method may be used, although it gives rise to fairly difficult practical problems of evaluation.⁵⁰ What must be emphasized,

however, are the special difficulties involved in estimating the value of services provided when the services are not sold on the market — when, in other words, they are services provided by public administrations. In national accounts the value of these services is generally estimated on the basis of the sum of the salaries paid to public service employees. This is an arbitrary convention. If used in calculating employment projections, this method is tautological in so far as the determination of the value of services provided by public administrations requires advance knowledge of the number of staff who will be employed on the date for which the estimate is made and the amount of their salaries. The determination of the level of output which, in this method, is a prerequisite for estimating productivity and thereafter the level of employment, is itself governed by a prior decision on the level of employment.

The concept of productivity is also inappropriate to the services sector. Technical progress and, consequently, productivity affect the individual divisions of this sector in different ways. In some divisions, the evolution of technical plant and equipment affects the level of employment and its distribution by occupation: this is the case with transport which, in this respect, is no different from the industrial sector. The concept of productivity has no meaning, however, in administration, education or health services. The quality of the service rendered is so material in the case of these services that the phenomenon of productivity, in other words output per hour, is of altogether minor importance, or is incompatible with the need to maintain or improve the quality of the service. On the other hand, the concept of productivity has the same value in some branches of the services sector as in industry. This applies to railways, whose productivity levels can easily be calculated on the basis of the service rendered. In banking, too, productivity estimates can be made;

(c) A third characteristic of the services sector is the existence of a considerable volume of underemployment in some countries. In this regard the situation differs from that in agriculture and industry. In the developing countries the traditional agricultural sector comprises most, and sometimes almost all the population, and underemployment is the general rule. In industry, even in those countries, underemployment affects only a limited section of the labour force since the possibility of dismissal, an essential characteristic of the services sector, eliminates the majority of surplus workers. The services sector includes a great many activities of a traditional type: self-employed peddlers, small providers of services — messengers, shoeblacks, water-carriers, carriers with only primitive means of transport such as a sailing-boat or a pedal vehicle — and small craftsmen. The number of workers employed in these categories may be very high and there may be considerable underemployment.

Even in countries at a higher economic level, underemployment exists among the poorly organized small tradespeople with a low turnover, among domestic workers and even perhaps in occupations which require

⁵⁰ These problems are dealt with in detail in the national accounting manuals.

higher levels of training, such as the legal professions. The services sector in these countries has features somewhat similar to those of the agricultural sector: persons who cannot find employment through lack of qualifications find refuge in this sector, even though the income they derive from their work is very low. Very little is known about this type of underemployment. If it is generally impossible to identify in the available statistics the workers engaged in activities of the traditional type, it is equally difficult to measure the extent of underemployment in occupations belonging to the modern sector of the economy. The absorption of this underemployment is one of the greatest problems for the future of these countries;

(d) Finally, there are a number of other characteristics which have a considerable impact on methods of projecting employment. In some sectors, such as public administration and community services, the generation of employment is a function of decisions by the public authorities, whereas in banking or transport only the needs of the economy are taken into consideration. In some cases, major groups of the services industries consist entirely of a few very large enterprises or administrations, such as railways; other major groups, such as personal services, comprise a very large number of small enterprises. Lastly, in public administration and in the health and education services, personnel norms may be fixed on the basis of technical studies of the needs of the population. Some of these norms are very specific.

This account of the principal characteristics of employment in the services sector shows the heterogeneous nature of the sector. A variety of methods will therefore be proposed for projecting employment in each division of the services:

There are five main approaches to be considered:

1. Determining the level of employment by abstraction from anticipated output and productivity;
2. Labour demand research in the form of detailed analysis of the factors governing the level of employment and its distribution by occupation in each division of the services sector;
3. The establishment of employment norms;
4. A survey of the projects undertaken by the public authorities in such areas as the development of administrative, health or cultural services;
5. Econometric methods of estimating labour demand through correlations with the probable trend of certain economic magnitudes, such as national *per capita* income.

Each of these approaches works well for some divisions, but is unsuitable for others. The question of how to combine projections arrived at by different methods has to be considered. The solution is to prepare at the same time a projection of future employment in this sector, using the aggregate approach methods which will be explained below in the sub-section 3 of this section.

2. Analytical method

This method is used to ascertain which of the five approaches mentioned above is to be adopted in a given case. In some instances employment projections may be established by using two approaches, the nature of the projections differing according to the method adopted. For example, the projection may deal with the probable trend of employment in one case, and with the desired trend in the other. In the account of the analytical method which follows, the divisions of the services sector will be dealt with in the order followed in the International Standard Industrial Classification of All Economic Activities.

(a) Commerce (division 6 of the International Classification)

Commerce may be divided into three major groups: trade proper, banks and insurance, and real estate.

(i) Trade proper

Trade, in most countries, has three principal features:

a. Considerable underemployment exists in retail trade, which comprises a great many small enterprises and in some cases even itinerant street vendors;

b. The structures of this major group change rapidly with economic progress. Street vendors tend to become fewer or to disappear in the more backward countries, as do small enterprises in countries whose economic level is already rising. New forms of trade appear or expand: self-service shops, supermarkets. This trend is reflected in a reduction of the number of own-account workers and employers and an increase in the number of salaried workers;

c. Occupations are not clearly defined. Only a few major categories can be identified: shop manager, salesman, unskilled employee.

The best method of projection will necessarily be based on changes in the structures of trade, account being taken of the relative importance which each form of trade will have in the future. A model must then be prepared; a model for retail trade, for example, will have the following components: the consumption of goods supplied by retail trade is divided into three main groups, namely, food, clothing and other items (such as furniture, leisure goods and electrical appliances). For each of these groups, the various possible structures of trade are determined. Turnover is distributed among these groups in the proportions indicated by the available data regarding the probable pace of change in the structures of trade (the rate observed in previous years, the trend of urbanization, estimated investment in modern forms of trade). The volume of employment for each trade group can then be estimated from the share of turnover assigned to each one. Research on these lines is currently being carried out in France, at the Centre d'étude de la population active et de l'emploi of the Institut national d'études démographiques, but this research has not yet been applied in practice.

In general, estimates of employment in trade are aggregate estimates derived from estimates of output and productivity. Output can be estimated on the basis

of the trade turnover which will result if the projections of industrial and agricultural output, and of consumption of the products of those sectors, prove to be accurate. This estimate is necessarily a very crude one and generally takes the form of a subtraction operation. The estimated output of trade as a whole, as indicated by the national accounts for the base year, is increased by a percentage equivalent to the growth of agricultural and industrial output. Productivity is estimated either by correcting the observed trend yielded by national accounts for previous years, if a statistical series is available (a method which has been applied in Argentina),⁵¹ or as a direct estimate of the productivity level, which generally assumes some decline in existing under-employment.

These projections are of little value. In fact, in the majority of countries, the number of people employed in trade is far too high. The development of the economy requires that labour employed in this sector should increase quite slowly by comparison with the growth rate of agricultural and industrial output;

(ii) *Banks and insurance*

a. *Banks*

The volume of banking activity depends on the size of the population, progress in economic activity and in the *per capita* income level, and the increasing use of credit and of personal deposit accounts. The increase in the labour force which should result from an increase in banking activity is checked by the mechanization of some operations and the use of computers. In the United States of America, employment in banking increased more rapidly than did national income until 1958; since then the development of new banking techniques has reversed that trend. The same should be true of other countries in future years, but only in cases where there is already a well-developed banking system. Elsewhere, future employment will depend to a great extent on decisions regarding the establishment or expansion of banking institutions. The employment projection must then be made on the basis of a survey of projects, as is often the case in the services sector.

A study of the structure of employment in this branch is of great importance, since the percentage of skilled and highly skilled labour is high.

b. *Insurance*

The same factors govern employment in banks and insurance companies: population growth, increased economic activity and income, and increasing use of the protection offered by insurance. Advances in operational techniques produce the same effects as in banking and the same reversal in the relationship between national income and employment has been observed in the United States of America since 1958.

In certain countries, however, where social security institutions have only recently been established or do not yet really exist, the development of insurance

institutions in future years will be very rapid. A study of government projects in this area is therefore essential;

(iii) *Real estate*

This group, which comprises real estate agents and managers of apartment buildings, employs only a small number of people in most countries. Projecting employment is very difficult for this group. In theory, employment should depend on the demand for housing, which is itself governed by demographic factors and the tempo of construction, but speculative activities have a considerable impact on this branch in some countries. It would appear to be impossible to establish independent projections here. The real estate industry can be dealt with only within the over-all projections made on an aggregate basis for the services sector (see the subsection 3).

(b) *Transport, storage and communication*

This division comprises many groups: railways, urban transport (tramways, underground railways), road transport, maritime transport, inland water transport, air transport, services incidental to transport (travel agencies, car rental), storage activities, and postal, telegraph and telephone services.

Two methods can be used: the employment projection can be derived from the planning projections of output and productivity, or the future labour demand can be estimated on the basis of a survey of transport investment projects being planned. The first method is particularly suitable for countries in which the organization of transport is unlikely to undergo any significant changes in future years, while the second is better suited to the situation in developing countries.

(i) Employment projected by abstraction from planning projections of output and productivity.

The procedure is the same as that described for industry: output and productivity are projected, total employment is determined, and then distributed by occupation.⁵² There are a number of difficulties in applying this method but they arise only in connexion with the transport sector.

Output in this sector can be measured by the number of tons or persons transported multiplied by the number of kilometres travelled. The measure used is that of the kilometric ton or the passenger kilometre. Then estimates of future transport usage have to be made and the research required is extremely complex. The estimates must be based not only on projections of economic activity, population growth and *per capita* income, but also on any proposed changes in the distribution of regional activities and, most important of all, on the transport policy pursued in the country concerned. The content of this policy will largely determine the relative shares of rail and road transport in goods traffic.

Projections of this kind for inland goods transport

⁵¹ Organisation for Economic Co-operation and Development, *Education, human resources and development in Argentina* (Paris, 1967), p. 334.

⁵² See Section B of this chapter, on forecasting methods for industry.

have been made in France, for example in connexion with the preparation of the Fifth Plan (see table 34).

Projecting the productivity of rail transport is not a difficult matter and the topic has been discussed in a number of studies. Moreover, railway administration in most countries is the responsibility of one or only a few companies and the calculations are facilitated by this administrative centralization. In the case of road transport, on the other hand, few statistical data are available on the evolution of productivity or on the factors which determine improvements in productivity.

Distribution of employment by occupation is not difficult if over-all employment projections have been made for each type of transport. The employment structures change little, except perhaps for the railways,

the modernization of which may create new needs for skilled manpower. These needs can easily be ascertained, however, by studying the example of foreign companies which are at a more advanced stage in the modernization of rail transport.

(ii) *Surveys of projects*

In many countries, especially the developing countries, the method just described is little used, because the transport system is not yet sufficiently developed. Whether the extra traffic will be absorbed by the existing rail or road transport systems and what modernization work will be carried out in the next few years — electrification of existing lines, for example — are not the only questions to be answered. The essential problem is that of assessing the extent of future develop-

TABLE 34
Estimated evolution of inland goods transport in France, 1963-1970

1. TRAFFIC STRUCTURE IN 1963

	Tons (millions)	Percentage	Kilometric tons (thousands of millions)	Percentage
Rail transport	240	46	64	60
Road transport, public and private, over distances of more than 50 km	169	32.5	27.5	26
River transport, public and private	76.2	15	11	10
Pipeline transport of crude and refined hydrocarbons	34.4	6.5	4.1	4
	519.6	100.0	106.6	100.0

2. TRAFFIC PROJECTION FOR 1970 (a) *Low assumption*

	Tons (millions)	Percentage	Kilometric tons (thousands of millions)	Percentage
Rail transport	275	40.5	75	54
Road transport, public and private, over distances of more than 50 km	235	34.5	40	28.5
River transport, public and private	100	14.5	13.5	9.5
Pipeline transport of crude and refined hydrocarbons	72	10.5	11	8
	682	100.0	139.5	100.0

(b) *High assumption*

	Tons (millions)	Percentage	Kilometric tons (thousands of millions)	Percentage
Rail transport	295	39	80	51
Road transport, public and private, over distances of more than 50 km	270	35	48	31
River transport, public and private	110	14.5	14.5	9.5
Pipeline transport of crude and refined hydrocarbons	84	11.5	13	8.5
	759	100.0	155.5	100.0

Source: France, V^e Plan de développement économique et social (Paris, Imprimerie des Journaux officiels, brochure No. 1278 bis 1966), vol. II.

ment of the transport system, which is often associated with the development of hitherto underprivileged regions.

In such cases a survey must be made of development projects contemplated and of the proposed technical arrangements for improving the transport system: the construction of railway lines, roads and ports. The volume of employment can then be estimated without difficulty, at least in the case of railways or ports, with the help of foreign models; in the case of roads, projecting new employment is much more difficult. The survey of posts and telecommunications projects is not particularly difficult, either in the matter of finding out what projects there are or in assessing their effects on employment. The fact that these activities are in the hands of centralized institutions makes research easier.

(iii) *Concluding comments*

In some developing countries there is still a traditional transport sector. A fairly large number of people are employed in such primitive means of transport as mules, hand-carts, or rowing or sailing boats. In Greece in 1965, 30,000 people were so employed. Productivity in this sector is extremely low, but the size of the sector will decline in the future. The magnitude of the decline cannot be estimated accurately but some account must be taken of it in the presentation of results.

(c) *Services (division 8)*

(i) Government services and community services (states, regions, municipalities)

The International Classification of Economic Activities classifies under this heading only the armed forces, the police, and those central and local administrations which are responsible for making regulations and supervising their application. Such public institutions as schools, hospitals, state banks, or publicly-owned railway companies are excluded from this division, which therefore covers only public administration in the traditional meaning of the term. In this sphere the concepts of production and productivity are meaningless. Each administration has a function to perform and must perform it in a manner which satisfies the population of the country.

Employment projecting procedure therefore differs according to the different functions performed by the administrations and the degree of complexity of existing administrative structures. Employment projections for the armed forces depend on political decisions which the projection staff can only record. Some uniform methods can, however, be applied in the case of the civil functions of government and community services. A list of the functions to be performed can be prepared. The list has grown steadily longer in recent years, even in countries in which administrative structures were already very complex. New functions arise, such as the supervision of newly-established social security institutions, the expansion of public employment and placement services, economic, social and urban research departments — essential for formulating State policy — and the organization and administration of new scientific research; and at the local level, urban development

demand a larger municipal administration, new municipal parking lots, and new recreation sites and centres. A second factor, population growth, must be taken into consideration, inasmuch as it is reflected in an almost proportional increase in the personnel of these services. The rising trend in personnel numbers is strengthened by rapid urbanization and the problems it creates for urban administrations.

In the developing countries the problem is somewhat different. It is not a question of giving the administration new functions, but of equipping it to perform its basic tasks. As in all other countries, the first step is to establish the list of functions. Here, however, estimates of labour demand are simplified, since it is relatively easy to use foreign models to determine this demand.

A second operation has to be undertaken in the case of most developing countries: the evaluation of the replacement (by nationals) of technical co-operation personnel. This is an important question because the demand for personnel, particularly skilled personnel, is influenced more by the replacement policy followed than by the reorganization of existing services or by new functions entrusted to administrations. The replacement policy for technical co-operation personnel will itself depend more on the projections of high-grade educational output in future years than on estimates of manpower requirements. The information sought is whether the country will have the skilled personnel required for at least some years to come.

(ii) *Community services*

a. *Education*

Two groups of workers take part in educational activities: teachers and the administrative staff of schools and universities. Only the first group will be discussed in the examples, which follow, since the problems of the second group are not different in kind.

The number of teachers depends largely on the following factors: the size of the population of school and university age, its geographical distribution — at least for the first stage of education — the education system at the time when the projection is made, social demand (desire of young people for education beyond the period of compulsory education, by stage of education and discipline) and government targets for the distribution of pupils and students by stage of education and discipline. The first of these is usually easily measured, but the last two are much more difficult to assess.

Government targets are dependent on the employment projections made for the economy as a whole. In this respect the projection of teaching staff is in a special position, inasmuch as a knowledge of one of the most important factors presupposes that all the research work on the evolution of employment in future years has been done. Thus the projection can only be made when that research is complete. Moreover, it should be noted that it is not sufficient to have estimated future additional manpower requirements by occupation: the requirements of replacements arising from deaths, separations, retirements and withdrawals from activity must be stated, and the recruitment needs thus derived

must be presented in terms of levels and types of education.⁵³

Social demand — the educational wishes of pupils and students — is generally badly documented. There have been investigations of this subject, particularly in France, but they are infrequent and give no over-all view of the way in which young people and their families want the school and university system to develop.⁵⁴ How important this shortcoming is depends on the organization of the educational system. The system may be based on an authoritarian assignment of the pupils to specific stages of education and disciplines, a *numerus clausus* being instituted to regulate access to each new stage which the pupils or students wish to enter. In this case, a knowledge of social demand is of no importance, except for measuring the discrepancy between the wishes of the students and their families, and the pattern of education desired by the public authorities. All that is required is to calculate the pupil-teacher ratios of the pupils and students, since their numbers have been determined by the accepted norms. Foreign models make these norms quite easy to calculate.

If the reverse is true — if the public authorities do not direct the young people's studies in an authoritarian fashion — the future size of the school, and university population after the period of compulsory education and its distribution by stage of education and disciplines become very difficult to estimate in the absence of an accurate knowledge of social demand. The estimates may be seriously wrong; France has had this experience recently. The inflow of students into the humanities faculties greatly exceeded the targets which the Government had set and which it was unable to impose, since all holders of secondary school-leaving certificates are free to enrol in their chosen faculties; teaching personnel requirements, which had been estimated in relation to the official targets and on the basis of planning projections of employment, were found to be too low.

b. Health

The International Classification puts under this heading all the medical and paramedical occupations (such as doctors, dentists and nurses) and the medical personnel of hospitals, clinics, sanatoria and dispensaries. The problems which have to be considered in the case of doctors will be taken as an example, those of the other occupations being very similar or, for non-medical personnel, much simpler. Much research has been carried out on the probable evolution of the number of doctors. Two methods can be used.

The first method looks at doctor density — the number of doctors it is desirable to have per 1,000 popu-

lation. Foreign references are chosen for this purpose. The application of this method raises one difficulty: doctor numbers cannot be studied in isolation and depend to a large extent on the organization of the health system. For a country in which the exercise of medicine is not subject to control, the model cannot be the doctor density of the countries of eastern Europe or the United Kingdom, which have national health services. The organization of hospitals, their density, the standard of equipment and the number of paramedical personnel (nurses, technicians) also affect this factor. Moreover, account must be taken of the proportions of general practitioners and specialists among all doctors, and how they are spread over the national territory. Doctor density is therefore a fairly crude way of estimating the number of doctors required. The method may serve a useful purpose in countries in which medical services are very poor. In more advanced countries, more complex research must be undertaken.

A second group of methods bases the calculation of the numbers of doctors required on detailed analysis of the effects of the various factors governing these needs. Some of the factors are easy to assess: population size and its distribution by age and by geographical zones. On the other hand, to estimate future growth in the consumption of medical services is a complex process. This form of consumption depends on many factors: age, longer lifespan, income level, cultural level, technical advances in medicine (development of preventive medicine and its efficacy, access to new forms of treatment), the organization of medicine (maintenance of a non-controlled system, establishment of a health service, share of public hospitals in services to the population), relative proportions of general practitioners and specialists, the working hours and length of medical studies which are to be taken as indicative of underemployment or overemployment among doctors, and lastly, in some countries, the low level of consumption caused by the lack or inadequate supply of doctors in certain regions.

Many models for projecting requirements of doctors have been prepared. Indeed, research on this subject began very early, the first projections being prepared in the United States of America in 1933. Many failures were recorded when these projections were compared with actual developments and experience has shown that projecting requirements of doctors is one of the most difficult parts of employment projections, whereas at first sight the opposite may appear to be true.⁵⁵

New models have now been prepared; they include one prepared for France by G. Rösch and S. Sandier.

⁵³ Refer to chapter VI which deals with ancillary estimates.

⁵⁴ A. Girard, "Les facteurs psychologiques et sociaux de l'orientation scolaire. Le cheminement d'une promotion d'élèves pendant les deux années suivant la sortie du cycle élémentaire" (Psychological and social factors in pupil orientation. The progress of a cohort of pupils during the two years following their leaving the elementary stage), *Population*, No. 4, July-August 1966, pp. 691-750.

⁵⁵ See, on all previous work: J. J. Gillon and J. du Guerny, "L'estimation des besoins en médecins" (Estimating requirements of doctors), *Bulletin de l'Institut national de la santé et de la recherche médicale* (Paris, Nov.-Dec. 1967), vol. 22. This article considers work done in the United Kingdom and in the United States of America; and J. Chassin du Guerny, "Exemples de prévision des besoins en médecins" (Examples of projections of requirements of doctors) (Germany, Netherlands, Italy), *Cahiers de sociologie et de démographie médicales* (Paris, Éditions du concours médical, Oct.-Dec. 1967).

In this, doctor requirements are estimated on the basis of an analysis of demand, expressed in single transactions (visits by and to the doctor).⁵⁶ For the United States of America, new projections were prepared in 1967 for the period 1966-1975 by the Bureau of Labor Statistics.⁵⁷ Another model which endeavours to incorporate factors influencing doctor requirements in the developing countries was drawn up on the same underlying principles by T. D. Baker and M. Perlman.⁵⁸ This model was applied experimentally in China (Taiwan). Three variables are used: the demand for doctors, the number of calls on the doctor per month (visits by and to the doctor) and the cost per call. These, in turn, depend on the following independent variables: age, income level, cultural level and residence. Sub-populations classified according to these criteria were estimated and the number of transactions and their cost determined for each of them. The average number of calls on a doctor by an individual in a specific sub-population is multiplied by the future numbers of that sub-population to obtain the total future number of calls per month by that sub-population, i.e. its future demand. The sum of the demands of all the sub-populations is estimated to obtain the total future demand. Lastly, that total is divided by the present average number of consultations. This yields the number of doctors needed, after adjustments are made for such factors as volume of work or desirable income per doctor.

This method calls for several comments. It applies only to doctors in private practice. It therefore assumes that private practice is the normal form of medical practice in the country studied and overlooks hospital work. Furthermore, the method does not allow for increased consumption stimulated by technical advances in medicine. Indeed, it bases the projections of the demand for doctors solely on changes in the size of each sub-population caused by demographic developments, a rising level of living, and educational progress. Lastly, the method is purely experimental: although it represents a definite advance in the techniques of analysing the consumption of medical services, its applications are limited.

Other models might be described, differing from these latter methods in points of detail but based on the same principles. They should probably be used very cautiously, particularly in developing countries. For these countries, especially if they fall far short of meeting the health needs of the population, the normative

methods described earlier seem to be both simpler and more suitable for the prevailing conditions.

c. Other community services

This is a very heterogeneous group in the Classification of Economic Activities: it includes scientific research, religious organizations, social welfare institutions, professional and political organizations, and museums and libraries. This sector has only a small share of the labour force in most countries. Employment levels change very little except in scientific research, where numbers may be estimated from surveys of future projects.

(iii) Business services

This major group includes the legal professions, accountants in professional practice, consultancy firms, advertising and journalism, although the primary purpose of the last of these occupations is not to render a business service.

In the highly developed countries, employment in this sector is expanding very fast: in the United States of America, it rose from 670,000 persons in 1959 to 980,000 in 1964; the figure forecast for 1975 is 1.8 million persons.⁵⁹ A similar rapid growth has also been recorded in other countries with highly developed economies.

The growth is less rapid in the developing countries, since the expansion of business service enterprises presupposes a high level of economic development. They should not, nevertheless, be overlooked, especially a large number of the young graduates in these countries wish to enter those professions — and more particularly the legal profession — in which most of the manpower in this sector is to be found. As the labour supply is very abundant, there is a distinct possibility that the growth of these professions will, in some countries, outstrip the actual needs of the economy.

The growth of employment in this sector is geared to the pace of economic activity in the country as a whole and to the emergence of new techniques in the provision of business services. The two phenomena are so closely interwoven as to render impracticable reliance on correlations, based on historical statistical series, between gross national product and the growth of business services. In any event, new kinds of business services will emerge in future years and will be utilized immediately in all countries experiencing economic growth. The increasing use of firms specializing in computer services is just such an example. Correlations based on past series are therefore useful only for the first estimate of future employment trends in this sector.

There is yet another phenomenon that should be taken into account. In many countries at an intermediate level of economic development, the numbers in some occupations, and especially in the legal profession, are already very high, either because of tradition or for the reasons given earlier, the most important of which is their attractiveness to young graduates. Manpower

⁵⁶ G. Rösch, "Méthodes d'estimation des besoins en médecins" (Methods of estimating requirements of doctors), and S. Sandier, "Estimation des besoins en médecins à partir des prévisions d'évolution de la demande" (Estimating requirements of doctors on the basis of demand projections), *Cahiers de sociologie et de démographie médicales* (Paris, Éditions du concours médical, April-June 1966, 6 [2]), pp. 106-112.

⁵⁷ United States of America, Bureau of Labor Statistics, *Health Manpower 1966-1975, Study of Requirements and Supply*, report No. 323.

⁵⁸ Timothy D. Baker and Mark Perlman, *Health Manpower in a Developing Economy: Taiwan, a Case Study in Planning* (Baltimore, The Johns Hopkins Press, 1967).

⁵⁹ United States of America, Bureau of Labor Statistics, *America's Industrial and Occupational Manpower Requirements, 1964-1975* (Washington, [D.C.], 1966), p. 107.

growth in these groups must accordingly be curbed. A conclusion to this effect was formulated in Argentina, for instance, as evidenced by the following passage from the OECD report:⁶⁰

"The number of jurists per 10,000 inhabitants is very high indeed in Argentina, a relatively high proportion of law graduates actually choosing this occupation. There is no economic or social reason why Argentina should need such a high proportion of jurists; we have, therefore, projected a symbolic increase in this category — from 23,000 in 1960 to 26,000 in 1980."

(iv) *Recreational and personal services*

These services are classified into three groups: household and traditional service occupations, hotels and restaurants, and other kinds of personal services.

a. *Household and traditional service occupations*

The number of private household workers is steadily contracting in every country. Extrapolation of past trends is the only means of projecting employment in this occupation. Experience shows, moreover, that the declining trend is maintained without interruption.

Besides the private household workers, the group includes workers employed in such traditional services as boot-blacks, who are very numerous in the developing countries, but whose numbers will diminish as economic growth proceeds;

b. *Hotels and restaurants*

Two sets of factors are predominant among those governing employment trends in this sector: higher living standards expressed in terms of national income *per capita* and population growth, on the one hand, and the prospects for the expansion of the tourist industry, on the other. Projections involving the latter must be based on a survey of projects for the building or modernization of tourist resorts. For the former set of factors, correlations between national income and hotel and restaurant activity may be established and these have been applied tentatively here;

c. *Other personal services*

This group includes hygiene (hairdressing, laundry, services involving personal care) and recreational activities. The correlation between the expansion of these services and the growth of national income, especially *per capita* income is, in theory, markedly positive. However, few practical applications of this device have so far been made. Account has to be taken of the very substantial underemployment in some countries in which this sector is overcrowded. Projections will therefore often use moderate assumptions and yield figures lower than those obtained by a correlation with population growth and that of national *per capita* income.

(v) *Concluding observations*

No detailed account exists of methods of distributing employment by occupation within the major groups of the services sector, although such a distribution is very often required in connexion with estimates of employment. The structure of employment changes very little in these major groups. In some instances, a single occupation represents the whole group, as in the case of private household workers, hygiene or teaching.

Moreover, an analytical study of employment trends within the various service industries is indispensable, as it is the only method of obtaining sufficient detail in the projections. The analytical method has its dangers, however, because new kinds of services are emerging, and it is impossible to enumerate all the services that will be developed in a given country or to estimate the numbers that each will recruit. Very rapid advances are being made in this sector: in the highly developed countries, car hire and firms supplying computer services are instances of new activities having a very fast recruitment rate and involving fairly substantial numbers of persons. This pattern will recur in future, not only in these countries, but also in the developing countries, which may well "catch up" more quickly than an analytical study can anticipate. The danger therefore is that an analytical study may overlook some service industries which will gain importance or underestimate the growth of others. Hence it must be supplemented by an aggregate approach to future employment trends in the services sector.

3. *Method of aggregate estimation of future employment in the services sector*

The characteristics of the services sector make the use of methods involving estimates of future total output and productivity per sector — or industrial division — impossible.

There is another method which might be employed: a correlation between expected future trends in population and in national *per capita* income, and employment in this sector. However, the presence of substantial underemployment in the service industries of many countries militates against its use. In any event, even in the most advanced countries where such underemployment does not exist, the correlation is not consistent over time; it is based upon a law of growth in demand which allocates an increasing share of all demand to the services industries, as consumers press for more and better services for themselves (in, for instance, education, health, hygiene, recreation and urban administration) and enterprises make increasing use of the facilities of consultancy firms, advertising services, and computer-based management services for small and medium firms. Such changes in the structure of demand may, however, be temporarily checked by a new cycle of growth in the consumption of industrial goods — such as cars or electrical household appliances — under the stimulus of a rapid improvement in industrial productivity. When this occurs, the tertiary sector's share in rising employment may grow somewhat more slowly.

⁶⁰ Organisation for Economic Co-operation and Development, *Education, Human Resources and Development in Argentina* (Paris, 1967), pp. 353-354.

Substantially improved prospects for the export of industrial goods may have the same effect. The level of total employment in the services sector cannot therefore be accurately estimated by this method, although some interesting research may be undertaken along these lines in order to produce an outline projection, and to check projections made by the analytical method.

Mention should be made of an even cruder method, based on statistical observations relating to the past performance of employment in industry and in the services. Table 35 shows how the proportion which employment in industry and the services represents in the total employed labour force changed in a number of countries in 1950-1960. Two groups of countries are considered: the most advanced countries and a set of developing countries. The increase in the shares of both sectors is much smaller in the first group than in the second, because rural-urban drift was less marked. In the first group, differences between the relative growth of employment in the services and in industry are generally very slight. In nine cases out of fourteen, the services sector comes off best. In the second group, the share of both sectors in the total labour force increased, sometimes sharply; there was a substantial difference between the two sectors in many instances. Two new country groupings emerge: in the Latin American countries employment increased more quickly in the services than in industry; in the countries of Eastern Europe and Asia, the increase in industry's share of the total labour force was usually double that of the services.

These distinctive patterns of performance reflect the characteristics of employment in the two groups of countries. The slightly faster growth of the services that occurs in the first group is a normal feature in countries which have been industrialized for many years.

The rapid growth of the services in the developing countries' group represents an employment movement which is seldom desirable. Its two chief causes are: the fact that too many new graduates are being admitted into tertiary-sector occupations, largely because of their unduly narrow literary or legal background, and the persistence — and in some cases the worsening — of underemployment, often as the result of an influx of rural migrants which the cities' employment market cannot absorb. In such cases, there is a rise not only in unemployment but also in the number of jobs in the tertiary sector. The numbers employed in the traditional service occupations — petty trading and personal services — increase disproportionately. The desirable trend in these countries, except where there are no prospects at all of industrialization, is faster growth in industry's share of total employment. Such a trend is the product of two factors: the volume of industrial investment and a planned effort to reduce underemployment in the services. This was the conclusion reached in Argentina: whereas employment rose by 18.5 per cent in industry and 21 per cent in the services in 1950-1960, the OECD projections for 1980 yield, depending on the assumption used, a total rise of 64 per cent or 53 per cent for

industry, and 50 per cent or 44 per cent for the services.⁶¹ It should be noted, however, that underemployment in these countries does not involve very substantial

⁶¹ Organisation for Economic Co-operation and Development, *Education, Human Resources and Development in Argentina* (Paris, 1967), p. 332.

TABLE 35
Changes in industry's and services' shares of the total labour force in recent years (percentage)

1. COUNTRIES IN WHICH LESS THAN 50 PER CENT OF THE LABOUR FORCE WAS EMPLOYED IN AGRICULTURE IN THE BASE YEAR

	Reference years	Industry	Services
Northern America			
Canada	1951-61	-2.7	+20
United States	1950-60	+8	+6
Europe			
Austria	1951-61	+8	+20
Belgium	1947-63	-8	+27
Denmark	1950-60	+9	+10
France	1954-62	+8	+11
Germany (Federal Republic of)	1950-61	+11	+16
Luxembourg	1947-60	+10	+20
Norway	1950-60	0	+19
Netherlands	1947-60	+17	+7
Sweden	1950-60	+10	+8
Switzerland	1950-60	+9	+6
Oceania			
Australia	1954-61	-2.5	+6.5
New Zealand	1951-61	+6	+4

2. COUNTRIES IN WHICH OVER 50 PER CENT OF THE LABOUR FORCE WAS EMPLOYED IN AGRICULTURE IN THE BASE YEAR

	Reference years	Industry	Services
Latin America			
Brazil	1950-60	+23	+23
Costa Rica	1950-63	+12	+15
El Salvador	1950-61	+13	+10
Mexico	1950-60	+12	+18
Nicaragua	1950-63	+7	+41
Panama	1950-60	0	+17
Paraguay	1950-62	0	+8
Asia			
India	1951-61	+50	-6
Pakistan	1951-61	+25	+15
Philippines	1948-62	+55	+26
Thailand	1947-60	+100	0
Europe			
Bulgaria	1946-56	+46	+45
Hungary	1949-60	+67	+4
Poland	1950-60	+22	+26
Turkey	1955-60	+11	+22
Yugoslavia	1953-61	+44	+23

SOURCE: S. Baum, "The world's labour force and its industrial distribution, 1950 and 1960", *International Labour Review*, vol. 95, Nos. 1-2, January-February 1967, pp. 96-112.

numbers of people and that industrial development has been brisk since 1960. In less advanced countries, the difference between the two sectors will be even wider.

In the case of the developing countries, if a comparison of the employment projections for the services and industry indicates that the share of industry is to grow more quickly, the different rates of growth

must be justified either by an analysis of the future structure of demand and of the distribution of the increase in demand between industrial goods and services, or by the anticipated growth of external trade. This is a crude method of verifying the coherence of the projections for both services and industry and of preventing any severe distortions which might arise from undue reliance on the analytical study.

Chapter VI

ANCILLARY ESTIMATES

Projections of employment by occupation prepared by the methods described in the preceding chapters enable the effects of the anticipated development of the economy on employment structure to be assessed. They are not, however, suitable for use for the formulation of an energetic employment policy or a national education policy geared to the growth of labour demand in the economy.

What such projections in fact provide is a statement of the occupational distribution of the economically active population for a future year. By subtracting from these estimates the observed figures for the base year, the manpower requirements for the expansion of the economy can be determined. It may emerge, for example, that the recruitment of 40,000 engineers will be necessary if the economy is to expand sufficiently to attain the targets embodied in the Plan of the country concerned. The recruitment of that number of engineers in the coming years will not, however, meet all the requirements of the economy; there is also the need to replace personnel now working. During the period covered by the projection, some engineers will be separated from the labour force by death or retirement and will have to be replaced. Hence a projection of the manpower required for the expansion of the economy is not sufficient. It has to be supplemented by an estimate of replacement requirements in order to obtain the total future recruitment requirements.

There is a further difficulty in the use of employment projections by occupation: it is only rarely that the system of education gives pupils specific training for an occupation. Usually there is no close relationship between the training given and the job performed; such a relationship exists only in the case of certain manual occupations or in certain university-level professions, such as that of physician. In other cases, the pupil or student receives a general training, which can be used in a number of very different occupations.

Accordingly, projections of employment by occupation are of no direct use to the educational authorities, except in the special cases just mentioned. The chief concern of national education authorities is how to divide up the numbers of pupils and students among the various stages of education — short-term secondary education, full secondary education and higher education — and, within these stages, among the types of training which can be given: literary or scientific training in higher education, and general or technical training in secondary education.

For this purpose the employment projections have to be transposed to another context in which the distribution is by level and type of training. Information on employment prospects can then be used for the formulation of national education policy.

The ancillary estimates involved are explained below.

1. *Estimation of replacement and recruitment requirements*

(a) *Estimation of replacement requirements*

Some persons who were economically active during the base year will no longer be among the economically active population in the final year of the projection: they will have died or ceased their occupational activity. Ways of estimating their numbers were described in chapter III. Those estimates, however, covered the total economically active population distributed by sex and age group; separations were not distributed by occupation. This breakdown is necessary if the replacement requirements, for each occupational group, are to be estimated. Some comments on the methods to be used for this purpose follow.

(i) *Estimating deaths*

If only the age-specific distribution of the economically active population is available, deaths among the economically active persons from the base year until the final year of the projection will be the aggregates for each age group, estimated by the methods described in Part One of this manual. The deaths will then be distributed by occupation as if the age-specific distribution of workers was the same in all occupations.

This assumption is false: in some occupations workers are recruited at a later age than in others — doctors, for example. Moreover, in some occupations numbers have increased only in recent years; this is the case with electronics specialists or industrial designers, for example. In all these cases the age pyramid is distorted inasmuch as the economically active population in the occupation concerned has a higher or lower average age than the economically active population as a whole. Accordingly, when age distributions are available for the major occupational groups, mortality rates must be applied to the age pyramid for each occupation. Lastly, it is now accepted that mortality rates vary according to social environment. When these variations are known, it is preferable to use the mortality rates by social category.

(ii) *Estimating retirements and premature withdrawals from activity*

Of the survivors (at the end of the projection period), some will no longer be active. Some will retire; others, women in particular, will give up their occupational activity for other reasons — illness, marriage, birth of children.

The estimates of probable trends in labour supply described in Part One yield the sex-age-specific activity rates of the economically active population during the final year of the projection and its absolute numbers. If the base year and the final year are seven years apart and these years are taken to be 1968 and 1975 respectively, these estimates will show how many of the survivors in 1975 will still be economically active and how many will have withdrawn from activity. These figures are obtained by subtracting from the number of survivors — estimated by the methods explained above — the number of economically active persons of the same age, as given by the estimates of total population and activity rates.

The figure thus obtained is, however, the product of two phenomena: retirements and withdrawals from economic activity between 1968 and 1975, on the one hand, and entries and re-entries into the economically active population of persons of the same age in the same period, on the other. Only the end result is known. If, for example, a certain number of women aged forty in 1968 leave the economically active population between that date and 1975 for a reason other than death, other women of the same age in 1968 and then economically inactive will take a job, perhaps because their children have grown up. There is no way of separating these two movements. The activity rates for age forty-seven in 1975 include economically active women who were aged forty in 1968 and have not given up work and women of the same age who were not economically active in 1968 but went back to work during the following seven years.

In any case, total replacement requirements arising from retirements and withdrawals from occupational activity can, as stated earlier, be estimated as being the difference between the total number economically active in 1968 and the economically active survivors in 1975, bearing in mind that the group is not necessarily composed of the same persons in the two years.

The distribution of these replacement requirements by occupation is a difficult matter. Again, two assumptions are used, firstly, that the age distribution within each occupation is the same as that of the total economically active population — the same assumption used in estimating deaths — and secondly, that there is a single pattern among workers in all non-agricultural occupations with regard to age of retirement and, for women, age of withdrawal from activity. The patterns are obviously very different in agriculture, in which most economically active persons continue to work for as long as possible. On this basis, if 10,000 women aged forty in 1968 will have left the non-agricultural economically active population in 1975, and taking into account the activity rates projected for age forty-

seven in 1975 and the fact that female workers represent 30 per cent of the female economically active population, it is assumed that 3,000 female workers will leave the economically active population between 1968 and 1975 at those ages. This figure will be subtracted from the total female economically active population in 1968.

A better approach is to vary separation rates according to occupation. The application of this method is very difficult in practice because of the lack of statistical information on the real ages of female retirement or withdrawal from occupational activity, by occupation.

The age of retirement is not the same, however, for traders and civil servants, or, more generally, for independent workers and employees. In the case of independent workers, the statutory retirement age is not of great significance, because retirement does not always entail completely giving up work. In any event, the practice of workers with regard to retirement is far from being stabilized and is changing very rapidly at present. In this connexion the development of pension systems is very influential. In France, for instance, the pension scheme under the general social security system was instituted only around 1930. A worker must have contributed for thirty-five years in order to receive a full pension; only a few years ago, no worker could claim that full pension. The number of workers now claiming is increasing very rapidly. Such a situation has an appreciable effect on the age of retirement and, even more, on its association with withdrawal from all occupational activity.

The attitudes of women towards their occupational activities are no less variable. Some women are much more steadily employed than others. Those who only take a job for financial reasons leave it as soon as the income it provides is no longer indispensable, whereas the woman who is interested in her work keeps her job longer. The main factor in these differences is the level of the woman's educational attainment: the higher the level, the longer the duration of the professional career. Female occupations can therefore be classified into several groups in relation to the level of qualification which persons in these occupations are normally required to have. A second assumption is then applied: that differences observed in the base year between the activity rates of each of these groups and average female activity rates will be maintained in future. This procedure yields fairly accurate estimates of replacement requirements by occupational group.

(b) *Estimating recruitment requirements*

The sum of the labour requirements created by the expansion of the economy — as estimated by the methods described in Chapter V — and of replacement requirements gives the total recruitment requirements which the economy will have to meet in future years. The interpretation of these estimates calls for some comments.

(i) *Developed countries*

Replacement requirements are a very high proportion of total future recruitment: about 75 per cent. The purpose of three-quarters of all recruitments will

therefore be to replace existing personnel; the proportion of total recruitment which arises from the growth of the economy is relatively small. This observation shows how dangerous it would be to base a policy of vocational training and placement solely on the probable growth of employment, estimated in relation to the development of the economy. The primary function of training institutions remains, even in an expanding economy, that of supplying the necessary personnel to replace workers who die or give up their occupational activity.

In certain occupations in which the total numbers employed are expected to decline appreciably in future years, the volume of deaths and retirements is such that, despite this expected contraction, there will be a need to recruit new personnel.

In other occupations, the expected over-all growth in numbers is very small but replacement requirements are so high that over-all future labour requirements will remain high. In France, metalworking provides a good example of this situation: the total increase in numbers employed in 1970 amounts to only 85,000 workers, or 6 per cent of the 1962 numbers, but the labour needed to replace existing personnel amounts to almost 250,000 persons, or 18 per cent of the 1962 numbers. There will have to be an average annual recruitment of about 40,000 metalworkers, whereas the estimated requirements created by the growth of the economy alone equal an average annual recruitment of 10,000 workers.¹

It is only in occupations which are expanding intensively that the proportion of replacement requirements is less than 50 per cent. There are two reasons for this situation: the magnitude of the economy's new needs and the fact that these occupations are sometimes of recent creation. Foreseeable deaths and retirements are therefore few. This applies, for example, to electricians and radio technicians: the proportion of replacement requirements is only 35 per cent of total recruitments in France between 1962 and 1970. For scientific and technical workers, the proportion of replacement requirements is 41 per cent for engineers but only 23 per cent for technicians and technical officers, and less than 20 per cent for research personnel.

Lastly, in some cases recruitment requirements are negative. In France, this is the case with farmers and loggers, seamen and fishermen. The cause is the steep fall in numbers expected as a result of the modernization of production techniques in the sectors in which these workers are employed. This fall exceeds the number of deaths and retirements of farmers and seamen expected in the coming years, which means that some workers employed at these occupations in 1962 who

will not have reached retirement age by 1970 or 1978 will have to give up their occupations in order to find work. They will have to be retrained.

(ii) *Developing countries*

The proportion of replacement requirements is very small in most skilled occupations. This is because these occupations have only recently begun to grow. The numbers employed in the occupation during the base year of the projection are large and usually young, and few deaths and retirements, if any, need to be allowed for. There is, however, one additional factor to be taken into account: the "nationalization" of employment opportunities, as reflected in the replacement of foreign workers, usually in posts requiring a high level of skill, by national workers. In these circumstances the proportion of replacement requirements may be relatively high.

On the other hand, replacement requirements in the case of unskilled personnel, and particularly of the economically active agricultural population, are high. These requirements must be estimated, since their inclusion in the estimated recruitment requirements will make the distribution of these latter by occupation or level of skill very different from one in which only demand created by the growth of the economy is taken into account. The proportion of agricultural workers to be trained remains high. These workers will probably have to have a level of training higher than that of the workers they replace. Nevertheless, the fact that the replacement requirements of the agricultural sector are taken into account imposes on the educational system the need to provide for a substantial volume of agricultural training, when provision for the requirements of a growing economy alone would lead the educational system to emphasize urban occupations which are likely to expand greatly in future.

2. *Distribution of recruitment requirements by level and type of training*

If projections of recruitment requirements are to be useful for formulating vocational guidance policy for the various stages of education, the future manpower recruitment requirements must be presented in terms of levels and types of training; this necessitates a different breakdown, since the requirements have hitherto been expressed by groups of occupations. A classification of levels and types of training must therefore be prepared. The equating of the various occupations for which employment projections have been made with specific levels and types of training will be performed by means of a cross-tabulation.

(a) *Principles of the classification of levels and types of training*

There are two questions to be considered: the classification of levels of training and the breakdown, within each level of training, by category of discipline. This latter classification distributes each of the levels by type of training.

¹ See C. Vimont and N. Dubrulle, "La prévision de l'emploi dans le cadre du V^e Plan en France; 2^e partie : essai de calcul des besoins de recrutement par niveau et type de formation" (Projecting employment within the context of the Fifth Plan in France; part II: Experimental estimate of recruitment requirements by level and type of training), *Population*, No. 5, September-October 1966, pp. 887-914.

(i) *Levels of training*

The criterion used in this classification is the degree or certificate which persons employed in a given occupation are normally expected to have. This is a better criterion than total period of education: after all, the same level of training may be acquired through quite different periods of study, so the more precise concept of degree or certificate is to be preferred. That the standard reference is the degree or certificate does not mean, however, that all those recruited for a job which is classified at a given level must actually be holders of the document concerned; it is sufficient if their level of attainment is equivalent to that required for the post to be filled, although they may have reached that level by means other than obtaining the degree or certificate in question — by, for example, long experience in the occupation.

The structure of the classification adopted will have to correspond to the main divisions of the educational system and will therefore vary from country to country. The outline remains the same, however: the first level corresponds to the completion of compulsory education; the two following levels correspond, respectively, to short-term technical education leading to employment as skilled workers and to full secondary education; there are one or two further levels, depending on whether higher education is considered as a whole or in two steps, when the university structure makes a clear distinction between these two steps. It must be understood, in this connexion, that the degree (*licence*) cannot be separated from the doctorate (*doctorat*), since, for occupational purposes, no very clear distinction can be made. Each of these levels, therefore, represents one output point of the school and university system.

(ii) *Types of training*

A distribution by type of training must be made within each level of training. In the case of higher education, the traditional divisions of Law, Arts, Science and Medicine are generally used, higher commercial studies being included under Law. In the lower levels, on the other hand, the distribution is by sector of economic activity: agriculture, industry, administration, commerce, health, and social services. The concept of a discipline, in the true meaning of the term, hardly applies, of course, to these kinds of training. No distinctions are made within the level which corresponds to the completion of compulsory education, since it involves no specialization.

(b) *Distribution of occupations by levels and types of training*

It is not always the case that for each occupation there is a single level and type of training, as with doctors, who constitute a definite and homogeneous profession. The classification of occupations reflects this fact. Thus, the term "clerical worker" covers a group of occupations for which different levels of training are required. Sometimes, too, distribution by type of training becomes a difficult process: not all senior civil servants, for example, can be classified as

having legal training — some may have a literary or scientific background.

A further difficulty arises from the fact that the demands of enterprises as to the level of training desired for many occupations change gradually. Secondary school teachers have always been required to have a university degree. The level of the qualifications required for senior administrative personnel has risen appreciably in recent years and will rise further in future. The same applies to many other occupations — it is affecting all skilled workers, for example. As the satisfaction of the needs of the economy becomes more complex, the requirements of enterprises become more exacting.

The requirements of the economy are not the only reason why most enterprises demand higher levels of training from their employees. The increase in the numbers of those holding university degrees or certificates of technical education also influences this process. If the law faculties have an abundant output of degree-holders, enterprises will be much more exacting when they recruit personnel with legal training than if the number of new graduates were very small. The labour market, like all markets, is governed by the volume of both supply and demand. If demand changes, recruitment conditions are altered. In the coming years considerable changes are anticipated. The number of persons qualifying after longer periods of education — higher education, full technical education — is going to rise very rapidly, both as an absolute figure and as a proportion of each non-adult age group.

Lastly, another difficulty may arise: some countries have created new levels of training.

Accordingly, the cross-tabulation of occupations and equivalent levels and types of training cannot be based on current training requirements. What is needed is to translate recruitment requirements into terms of levels and types of training for periods when the number of young graduates and certificate-holders will have risen considerably and the complexity of the economy's requirements will have increased still further. In any event, the statistical information available on the current requirements of the economy in this field is very sparse. Population censuses provide a distribution of the numbers in each occupation recognized in the classification by level of training but not by age group. The only information which might serve the demographer's purpose would be a distribution by level of training of the younger workers, whose qualifications most nearly approach the present requirements of enterprises.

In these circumstances, the following solution has been adopted in France. Norms have been set for the standards of qualifications which are regarded as likely to be sought about 1970. These norms were established after consultation with experts chosen, *inter alia*, from the Planning Commissions. It has been assumed, for example, that for the occupation of farmer, for which only a small number of graduates or certificate-holders are at present recruited, there will be a fairly sharp rise in the educational requirements; this assumption is based on consultations with

TABLE 36
Theoretical distribution of occupations by levels and types of training for new entrants
into the active population, France, 1962-1970

	Levels ^a						
	I ^a and II	III	IV	V	VI	Total	
	(Percentages of each row or occupation)						
Scientific and technical workers (other than management staff):							
Engineers	100 B	—	—	—	—	100	
Architects	100 B	—	—	—	—	100	
Technologists and technicians:							
Chemists	—	30 S	70 B	—	—	100	
Building technologists	—	20 S	80 B	—	—	100	
Transport technologists and supervisors	35 B	45 S	20 B	—	—	100	
Forestry technologists	—	—	100 B	—	—	100	
Other technologists and technicians	—	30 S	70 B	—	—	100	
Draftsmen	—	10 S	50 B	40 B	—	100	
Administrative personnel (other than management):							
Middle-level personnel	10 A	(10 L) (35 DC)	45 C	—	—	100	
Office workers	—	10 DC	15 C	70 C	5	100	
Commercial personnel (other than management):							
Merchants:							
Wholesalers	5 A	40 DC	40 D	15 D	—	100	
Food retailers	—	10 DC	15 D	75 D	—	100	
Other traders	5 A	25 DC	40 D	30 D	—	100	
Hoteliers, restaurant operators	—	—	30 D	70 D	—	100	
Commercial employees	2 A	5 DC	25 D	40 D	28	100	

^a Roman figures indicate levels; letters indicate disciplines:

Levels I and II: higher education (degree and doctorate); A: law and commerce; B: science; C: arts; D: medicine and pharmacy; X: other forms of training of levels I and II;

Level III: higher education below degree standard; S: science; DC: law and commerce; E: education; SS: social and health; L: arts;

Level IV: full secondary education. The distribution by discipline is the same as in level V;

Level V: short-term secondary technical education; A: agriculture; B: industry; C: administration; D: commerce; SS: health and social services; X: other forms of training of the same level;

Level VI: Completion of compulsory education.

the working group on vocational training of the Agriculture Commission of the Fifth Plan.² Table 36 gives some examples from the cross-tabulation used for the French Fifth Plan.

A similar method was used in Argentina. The educational profile of the new entrants was determined by the educational profile for each occupation as shown by population censuses. Thus, for managerial and administrative workers, the basis of reference is the 25-29 age group of which, in 1960, 30 per cent had secondary education, 10 per cent technical education and 18 per cent university education. Since these standards were regarded as being too low, the proportions for the new entrants were raised to 50, 12 and 26 per cent respectively, the latter figure being divided equally between science and engineering, and social sciences. For clerical and sales workers, the 20-24 age group served as a guide. The improvements projected for the new entrants consist in lowering the proportion of

persons with primary education, with a corresponding increase in the proportion of those with secondary education. In view of the development of modern distribution methods, the difference in the educational levels of these two groups should, in the view of the authors of the report concerned, be reduced. A distinction was also made in both groups between those who require full secondary education and those for whom the first stage will be sufficient. Some 12 per cent of the clerical workers had secondary education in 1960, but, as the study of the age structure in the report showed, the proportion of persons having secondary education had been rising — from 8 per cent, in the age group 45 years and over, to 20 per cent in the 20-24 age group. Since these standards were regarded as too low, it was decided to double, for the new entrants, the proportion of persons having full secondary education. In the case of sales workers, the analysis of the age structure also revealed an increase in the proportion of people with secondary education, though a much smaller one than in the case of clerical workers — from 2.8 per cent,

² Vimont and Dubrulle, op. cit., pp. 902-911.

in the age group 45 and over, to 6.5 per cent in the 20-24 age group. Doubling the latter figure would mean that, out of the 60 per cent of the new entrants projected to require a secondary education, about a quarter would have a school-leaving certificate.³

On the basis of these cross-tabulations, the estimates of recruitment requirements described earlier can be expressed in terms of levels and types of training. The picture which emerges provides the educational system with some idea of the future distribution of the economy's requirements by categories of training. A policy of educational guidance based on this picture can then be prepared. Three further comments are required, however, in order to give a clear indication of the limitations of this procedure.

The fact that a certain proportion of recruitments will in future be made at a given level of full secondary education does not mean that all enterprises or admin-

istrations will demand that candidates for vacancies should hold the relevant certificates. It will be sufficient if they have attained that level, and this they may do through professional experience or further training acquired on the job. Hence the promotion of workers already employed may meet part of the demand. Consequently, additional assumptions must be made as to the probable extent of such promotions in future years.

Moreover, not all young school-leavers seek employment. Account must be taken, for example, of the substantial percentage of girls who complete full secondary education courses, take and pass their examinations, but subsequently enter no occupation, or do so only for a very short time.

Lastly, the estimates are subject to further reservations because of the weaknesses of the cross-tabulations as a device for transposing jobs into levels and types of training.

Caution must therefore be exercised in the use of estimates of recruitment requirements by level and type of training.

³ Organisation for Economic Co-operation and Development, *Education, human resources and development in Argentina* (Paris, 1967), pp. 372-380.

Part Three
CONCLUSIONS

Chapter VII

COMPARISON OF LABOUR SUPPLY AND DEMAND

Supply and demand projections have hitherto been considered separately. This treatment was unavoidable because the techniques used in each case are very different. The resulting projections do, however, make it possible to compare supply and demand. This process is essential in order to determine whether the country will have full employment, a labour shortage or a serious unemployment crisis in future years. The aims of national economic policy may therefore be called into question if the estimates of future labour supply and demand indicate an adverse trend in the employment situation. If the comparison can be made in such a detailed fashion as to permit confrontation of, for example, requirements and available resources for the major occupational groups, it may form the basis for the formulation of employment and education policies which are in keeping with the country's economic development needs.

The comparison of labour supply and demand projections is, indeed, the principal purpose of projecting employment, but it raises complex technical problems. The difficulties arise from three sources:

1. The concept of labour supply relates to the economically active population, i.e. all persons already in employment or wishing to be employed; the labour demand projection relates to the number of job opportunities offered by the economy;

2. The methods used to project the two concepts are very different, as has been explained in Parts One and Two of the manual. Moreover, for both supply and demand, several methods may be used. The results are not necessarily consistent: labour supply, for example, may be calculated by extrapolation, whereas labour demand may have been estimated normatively;

3. As demonstrated earlier, in the present state of our statistical knowledge and our methods, much uncertainty prevails as to the quality of the projections. Comparison of anticipated supply and demand means dealing with two uncertain quantities.

The comparisons must therefore be made very carefully. A detailed account is given below of this process; it must be applied at two levels: aggregate employment and employment by occupation.

A. COMPARISON OF PROJECTIONS OF AGGREGATE SUPPLY AND DEMAND

The comparisons can take two forms, depending on the method of estimation chosen:

- (a) The figure for the economically active population, as estimated for the final year of the projection, is compared with the figure for the employment opportunities to be offered by the economy on that same date. The difference between the two data provides a theoretical estimate of unemployment prospects;

- (b) A more refined method, which is explained in chapters III and VI, projects supply by estimating entries into the economically active population between the base year and the final year of the projection. The movement of demand, in this case, is expressed by the evolution of the labour recruitment requirements of the economy between those two dates. These recruitment requirements are the mathematical sum of requirements due to economic growth and those associated with replacements of the economically active population by reason of deaths, retirements and all other forms of separation from the labour force during the period in question. In this method, the difference between supply and demand measures unemployment changes in relation to the observed figure for the number of unemployed in the base year.

The choice between these two methods of presentation depends on the statistics available, particularly those on the age distribution of employed workers at the time when the projections are made. If no accurate data exist, the second method cannot be used.

Whichever form of presentation is adopted, the same problems arise in comparing the results. In theory, the interpretation of the supply-demand difference should be a simple matter: if supply is higher than demand, the remainder represents anticipated unemployment. This estimate of unemployment is a very vulnerable one, however, given the uncertainty inherent in the projections of both supply and demand. In estimates obtained by subtraction, errors occurring in the two quantities may well be cumulative, and this procedure can therefore not yield an exact figure for future unemployment. For such an arithmetical remainder to be interpreted, it must be a large one, and the margin

to be regarded as significant will vary according to the quality of the estimation of future trends in supply and demand.

The difference, or remainder, once it has been calculated, must be subjected to detailed analysis. If it indicates excess labour demand, it means that the development projects contemplated are over-ambitious and cannot be implemented — at any rate with only the country's own economically active population. If the difference represents excess supply, it may be a warning of considerable unemployment in future years. Generally speaking, if the labour supply does not exceed demand by more than 3 per cent, the situation in most countries is one of frictional unemployment, which is commonly regarded as normal. If the difference is a larger one, there are real prospects of serious unemployment in future years. When the estimates involve both supply and demand changes and changes in unemployment, the interpretation of the remainder becomes even more difficult.

The analysis of the difference between projected labour supply and demand cannot be confined to a simple comparison of results. More detailed study is required of the methods by which supply and demand were calculated before the difference can be interpreted.

The first step is to check that the estimates are consistent with each other from the point of view of the approach adopted. A figure for labour supply calculated on the assumption that the activity rates of the population will be very high, because the country intends to make rapid economic progress, cannot be collated with a demand estimate based solely on an extrapolation of past trends, if the past economic development of the country has been slow. The basic assumptions must be the same in the two calculations. In particular, both projections must either be a simple extrapolation of trends, or be of a normative character.

The second phase of the detailed analysis concerns migration. Interpretation of the gap between supply and demand necessarily implies consideration of the possible existence of migratory movements whether desirable or unwelcome. Regardless of whether immigration or emigration seems probable, or is planned with a view to solving the problem of balanced employment, a quantified estimate of migration movements must be made and the figure added to the economically active population, in the case of immigration, or subtracted from it, in the case of emigration.

Lastly, there is yet another point to be studied: changes in the labour supply and in the employed labour force do not occur in isolation. A rapid rise in labour demand usually brings about higher activity rates among the marginal segments of the economically active population, particularly women. Economic crisis, on the other hand, is reflected not only in rising unemployment but in a fall in the activity rates of the same marginal groups of the economically active population. These phenomena have been observed frequently in developed countries. If the difference between projected supply and projected demand is a large one, the way in which the sex-age specific activity rates were estimated

will have to be re-examined. If demand exceeds supply, for example, it may well be that the labour supply projections are in fact too low because future female activity rates have been set at too low a level. The reverse can also be true. The required correction is difficult to make, because little exact statistical information is available on the subject.¹

In developing countries, the traditional sector of the economy, and subsistence agriculture in particular, is still very large; even greater caution must be exercised in comparing supply and demand projections. A comparison of total labour supply with the economy's total labour demand is virtually meaningless. A very clear distinction must be made between agricultural employment and non-agricultural employment. Genuine unemployment phenomena occur only among those of the population seeking non-agricultural jobs. In agriculture there is no unemployment in the usual sense, only seasonal or permanent underemployment of varying degrees of intensity.

Accordingly, an estimate must be made of demand and supply for non-agricultural occupations. This is a simple process in the case of labour demand, where the distinction is easy to make. For supply, however, a new concept has to be introduced: that of members of the economically active population seeking non-agricultural employment. This segment of population has itself two components: survivors of the present urban population of these countries who are assumed to be economically active in the final year of the projection, and migrants at present living in agricultural areas but expected to leave them during the projection period in order to seek non-agricultural employment in either a town or a rural commune. This estimate, which amounts to allowing for future rural-urban migration, is very difficult to compute.²

In some countries these estimates may reveal that the growth prospects for non-agricultural employment fall below the expected increase in the non-agricultural labour force, as defined above. This situation may occur even in countries which anticipate very high rates of economic growth, but in which the rises in urban population and in rural-urban migration are very sharp. This type of distortion is the cause of, for example, the unemployment which is at present a feature of the capitals of several African countries, despite the fact that their economic development has been relatively rapid in recent years.

¹ Thomas Dernberg, Kenneth Strand and Judith Duckler, "A parametric approach to labour force projections", *Industrial Relations* 6:1, 1966, pp. 46-48; Alfred J. Tella, "Labour force sensitivity to employment by age, sex", *Industrial Relations*, 4, 1965, pp. 69-83; Jacob Mincer, "Labour force participation and unemployment: a review of recent evidence" in Robert A. and Margaret S. Gordon, *Prosperity and unemployment* (New York, Wiley, 1966), pp. 73-112; and Denis F. Johnston, "The integration of supply and demand projections of labour force", 37th session of the International Statistical Institute, London, 1969.

² See chapter II, section A, which deals with estimations of rural-urban drift in developing countries.

If the detailed analysis appears to confirm the anticipation of unemployment or labour shortage, the original projections of labour demand and supply will have to be revised in order to find a point of equilibrium.

If unemployment was projected, the sectoral employment projections must be reviewed in order to ascertain whether supply figures can be increased in some sectors. Since, as a matter of principle, there can be no question of appreciably reducing the productivity of a sector without jeopardizing the country's economic development, serious consideration must be given to the possibility of increasing the output of some sectors, or perhaps, in some cases, adjusting the economy in such a way as to expand the sectors employing large numbers. In developing countries the anticipated rate of rural-urban migration may be revised, possibly necessitating changes in the country's agricultural policy and in the intensity of its efforts to modernize agriculture. The mode of income formation and distribution, including the wage structure, may have to be revised.³

When the projections point in the opposite direction, a further study will have to be made of the activity rates of the marginal groups of the economically active population — young people, adult women, old people — in order to see whether an increase in the rates can be stimulated; this will probably require policy measures to promote the employment of these workers. On the demand side, the sectoral productivity projections must be reviewed and possibly increased. If none of these contingencies seems likely, the only feasible assumption remaining is the reduction of the economy's growth targets.

B. COMPARISON OF LABOUR SUPPLY AND DEMAND PROJECTIONS BY OCCUPATION, AND BY LEVEL AND TYPE OF TRAINING

In countries in which projections by occupation and by level and type of training were prepared, these can be compared with the anticipated output of schools and universities in order to identify any potential shortage or surplus in major occupational groups and in individual levels and types of training, and, on that basis, to formulate detailed policy for vocational training and education. Such comparisons are possible, however, only if certain kinds of statistical data are available.

Not only must occupational projections have been prepared, but they must have been expressed in terms

of levels and types of training, through the use of the methods explained in chapter VI. There are, in fact, no exact parallels between a break-down of demand by occupation and a distribution by educational attainment — degree or certificate. For almost all occupations several types of training and several levels are accepted. Occupational demand, therefore, has to be translated into levels and types of training by means of a cross-tabulation which takes account of the distribution of the probable requirements of enterprises.

The total recruitment requirements by occupation must be estimated for the projection period; account has to be taken, not only of requirements arising from economic growth, but also of replacement requirements.

It should be possible to compare the resulting distribution of recruitment requirements by level and type of training with the anticipated output of graduates and certificate-holders for future years, distributed in the same manner. This kind of projection exercise presupposes a very full statistical picture of the school and university system, which is at present available in very few countries. If the comparison can be made, however, a detailed training and education policy can be worked out on the basis of the surplus and shortage situations identified by the comparison. What the comparison in fact does is to assess the probable output of qualified workers which will result from the present educational pattern followed by young people in the country's school and university system. If there appear to be unduly severe distortions as between the requirements of the economy and the objectives of the educational system, corrective measures may be proposed to restore the balance of demand and supply for each type of qualification.

Such detailed comparisons are not always feasible. Nevertheless, the information obtained on the future occupational structure of employment, even in the absence of some of the detailed calculations, may be such as to justify changes in the objectives of the educational system. Even crude comparisons between the occupational distribution of the economy's future labour demand and the distribution of pupils and students in schools and universities may highlight distortions, especially if they are substantial. For this reason projections of employment by occupation are useful, even without projections by level and type of training, as are projections of the requirements arising from economic growth alone, even without a study of the labour replacement movement. This applies even more strongly to the developing countries, in which replacement requirements are minimal in the case of highly-qualified personnel, since the absolute numbers employed at that level are small.

³ See on this point, the observations of Robinson Hollister in "Manpower problems and policies in sub-Saharan Africa", *International Labour Review*, vol. 99, No. 5, May 1969, pp. 515-532.

ANNEXES

ANNEX I

Japan: projection of the sex-age-specific activity rates of the population, 1965-1985; direct extrapolation for each age group, with correction coefficient (equation (a)) ^a

Sex and age	Activity rates							Ratio of increase (or decrease)				
	Observed		Projected									
	1955	1960	1965	1970	1975	1980	1985	1960/1955	1965/1960	1970/1965	1975/1970	1980/1975
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
<i>Males</i>												
15-19	52.1	50.7	50.2	49.7	49.2	48.7	48.2	0.9731	0.9901	0.9900	0.9899	0.9898
20-24	85.2	86.8	87.6	88.4	89.2	90.0	90.8	1.0188	1.0092	1.0091	1.0090	1.0090
25-29	93.7	96.0	96.6	97.4	98.2	98.9	99.5	1.0245	1.0063	1.0083	1.0082	1.0071
30-34	95.1	97.1	97.7	98.5	99.1	99.7	100.0	1.0210	1.0062	1.0082	1.0061	1.0061
35-39	95.8	97.2	97.9	98.6	99.3	99.8	100.0	1.0146	1.0072	1.0072	1.0071	1.0050
40-44	95.9	97.1	97.8	98.6	99.2	99.7	99.9	1.0125	1.0072	1.0082	1.0061	1.0050
45-49	95.5	96.7	97.4	98.2	98.9	99.5	99.9	1.0126	1.0072	1.0082	1.0071	1.0061
50-54	93.8	95.1	95.9	96.7	97.5	98.3	99.0	1.0139	1.0084	1.0083	1.0083	1.0082
55-59	88.7	89.5	90.3	91.1	92.0	92.8	93.6	1.0090	1.0089	1.0089	1.0099	1.0087
60-64	81.5	81.9	82.7	83.5	84.3	85.1	85.9	1.0049	1.0098	1.0097	1.0096	1.0095
65 and over	55.7	54.5	54.0	53.5	53.0	52.5	52.0	0.9785	0.9908	0.9907	0.9907	0.9906
<i>Females</i>												
15-19	48.3	48.9	49.4	49.9	50.4	50.9	51.4	1.0124	1.0102	1.0101	1.0100	1.0099
20-24	66.6	68.4	69.1	69.8	70.5	71.2	71.9	1.0270	1.0102	1.0014	1.0100	1.0099
25-29	51.5	50.1	49.6	49.1	48.6	48.1	47.6	0.9728	0.9900	0.9899	0.9898	0.9897
30-34	49.1	50.7	51.2	51.7	52.2	52.7	53.2	1.0326	1.0099	1.0098	1.0096	1.0096
35-39	52.4	54.4	55.0	55.6	56.2	56.8	57.4	1.0382	1.0110	1.0109	1.0108	1.0107
40-44	55.3	57.0	57.6	58.2	58.8	59.4	60.0	1.0307	1.0105	1.0104	1.0103	1.0102
45-49	54.2	56.5	57.1	57.7	58.3	58.9	59.5	1.0424	1.0106	1.0105	1.0104	1.0103
50-54	50.5	51.9	52.4	52.9	53.4	53.9	54.4	1.0277	1.0096	1.0095	1.0095	1.0094
55-59	45.9	45.8	45.3	44.9	44.5	44.1	43.7	0.9978	1.9891	0.9912	0.9911	0.9910
60-64	39.1	39.1	39.1	39.1	39.1	39.1	39.1	1.0000	1.0000	1.0000	1.0000	1.0000
65 and over	21.1	21.4	21.6	21.8	22.0	22.2	22.4	1.0142	1.0093	1.0093	1.0092	1.0091

ANNEX I (continued)

Sex and age (1)	Product of activity rates and inactivity rates						Correction coefficient				
	1955 (14)	1960 (15)	1965 (16)	1970 (17)	1975 (18)	1980 (19)	1960/1955 (20)	1965/1960 (21)	1970/1965 (22)	1975/1970 (23)	1980/1975 (24)
<i>Males</i>											
15-19	2,495.59	2,499.51	2,499.96	2,499.91	2,499.36	2,498.31	1.00157	1.0002	1.0000	1.9998	0.9996
20-24	1,240.96	1,145.76	1,086.24	1,025.44	963.36	900.00	0.90864	0.9481	0.9440	0.9395	0.9342
25-29	590.31	384.00	328.44	253.24	176.76	108.79	0.65050	0.8553	0.7710	0.6980	0.6155
30-34	465.99	281.59	224.71	147.75	89.19	29.91	0.60428	0.7980	0.6575	0.6037	0.3354
35-39	402.36	272.16	205.59	138.04	69.51	19.96	0.67640	0.7554	0.6714	0.5035	0.2872
40-44	393.19	281.59	215.16	138.04	79.36	29.91	0.71617	0.7641	0.6416	0.5749	0.2167
45-49	429.75	319.11	253.24	176.76	108.79	49.75	0.74254	0.7936	0.6980	0.6155	0.4573
50-54	581.56	465.99	393.19	319.11	243.75	167.11	0.80127	0.8438	0.8116	0.7638	0.6856
55-59	1,002.31	939.75	875.91	810.79	736.00	668.16	0.93758	0.9321	0.9257	0.9078	0.9078
60-64	1,507.75	1,482.39	1,430.71	1,377.75	1,323.51	1,267.99	0.98318	0.9651	0.9630	0.9606	0.9581
65 and over	2,467.51	2,479.75	2,484.00	2,487.75	2,491.00	2,493.75	1.00496	1.0017	1.0015	1.0013	1.0011
<i>Females</i>											
15-19	2,497.11	2,498.79	2,499.64	2,499.99	2,499.84	2,499.19	1.00067	1.0003	1.0001	0.9999	0.9997
20-24	2,224.44	2,161.44	2,139.19	2,107.96	2,079.75	2,050.56	0.97168	0.9897	0.9854	0.9866	0.9860
25-29	2,497.75	2,499.99	2,499.84	2,499.19	2,498.04	2,496.39	1.00090	0.9999	0.9997	0.9995	0.9993
30-34	2,499.19	2,499.51	2,498.56	2,497.11	2,495.16	2,492.71	1.00013	0.9996	0.9994	0.9992	0.9990
35-39	2,494.24	2,480.64	2,475.00	2,468.64	2,461.56	2,453.76	0.99455	0.9977	0.9974	0.9971	0.9968
40-44	2,471.91	2,451.00	2,442.24	2,432.76	2,422.56	2,411.64	0.99154	0.9964	0.9961	0.9958	0.9955
45-49	2,482.36	2,457.75	2,449.59	2,440.71	2,431.11	2,420.79	0.99009	0.9967	0.9964	0.9961	0.9958
50-54	2,499.75	2,496.39	2,494.24	2,491.59	2,488.44	2,484.79	0.99866	0.9991	0.9989	0.9987	0.9985
55-59	2,483.19	2,482.36	2,477.91	2,473.99	2,469.75	2,465.19	0.99967	0.9982	0.9984	0.9983	0.9982
60-64	2,381.19	2,381.19	2,391.19	2,391.19	2,381.19	2,381.19	1.00000	1.0000	1.0000	1.0000	1.0000
65 and over	1,664.79	1,682.04	1,693.44	1,704.76	1,716.00	1,727.16	1.01036	1.0068	1.0067	1.0066	1.0065

ANNEX I (concluded)

Sex and age (1)	Product of the ratio of increase (or decrease) and the correction coefficient				
	1960/1955 (25)	1965/1960 (26)	1970/1965 (27)	1975/1970 (28)	1980/1975 (29)
Males					
15-19	0.9746	0.9902	0.9900	0.9897	0.9894
20-24	0.9257	0.9568	0.9525	0.9479	0.9426
25-29	0.6664	0.9606	0.7773	0.7037	0.6198
30-34	0.6170	0.8029	0.6628	0.6073	0.3374
35-39	0.6863	0.7608	0.6762	0.5070	0.2886
40-44	0.7251	0.7696	0.6468	0.5784	0.2177
45-49	0.7519	0.7993	0.7037	0.6198	0.4600
50-54	0.8124	0.8508	0.8183	0.7701	0.6912
55-59	0.9460	0.9403	0.9339	0.9167	0.9156
60-64	0.9880	0.9745	0.9723	0.9698	0.9672
65 and over	0.9834	0.9924	0.9921	0.9919	0.9916
Females					
15-19	1.0130	1.0105	1.0102	1.0099	1.0095
20-24	0.9979	0.9997	0.9867	0.9964	0.9957
25-29	0.9736	0.9899	0.9896	0.9893	0.9890
30-34	1.0327	1.0094	1.0091	1.0087	1.0085
35-39	1.0325	1.0086	1.0082	1.0079	1.0079
40-44	1.0219	1.0068	1.0064	1.0060	1.0056
45-49	1.320	1.0072	1.0068	1.0064	1.0060
50-54	1.0263	1.0086	1.0083	1.0081	1.0078
55-59	0.9974	0.9873	0.9896	0.9894	0.9892
60-64	1.0000	1.0000	1.0000	1.0000	1.0000
65 and over	1.0247	1.0161	1.0160	1.0158	1.0156

* Computations:

$$\begin{aligned}
 (4) &= (3) \times [100 \pm (25)] \\
 (5) &= (4) \times [100 \pm (26)] \\
 (6) &= (5) \times [100 \pm (27)] \\
 (7) &= (6) \times [100 \pm (28)] \\
 (8) &= (7) \times [100 \pm (29)] \\
 (9) &= (3) : (2) \\
 (10) &= (4) : (3) \\
 (11) &= (5) : (4) \\
 (12) &= (6) : (5) \\
 (13) &= (7) : (6) \\
 (14) &= (2) \times [100 - (2)] \\
 (15) &= (3) \times [100 - (3)]
 \end{aligned}$$

$$\begin{aligned}
 (16) &= (4) \times [100 - (4)] \\
 (17) &= (5) \times [100 - (5)] \\
 (18) &= (6) \times [100 - (6)] \\
 (19) &= (7) \times [100 - (7)] \\
 (20) &= (15) : (14) \\
 (21) &= (16) : (15) \\
 (22) &= (17) : (16) \\
 (23) &= (18) : (18) \\
 (24) &= (19) : (19) \\
 (25) &= (9) \times (20) \\
 (26) &= (10) \times (21) \\
 (27) &= (11) \times (22) \\
 (28) &= (12) \times (23) \\
 (29) &= (13) \times (24)
 \end{aligned}$$

ANNEX II

Japan: projection of the sex-age-specific activity rates of the population, 1965-1985: direct extrapolation for each age group with correction coefficient (equation (b)) ^a

Sex and age	Activity rates							Ratio of increase (or decrease)				
	Observed		Projected									
	1955	1960	1965	1970	1975	1980	1985	1960/1955	1965/1960	1970/1965	1975/1970	1980/1975
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
<i>Males</i>												
15-19	51.2	50.7	49.3	47.9	46.5	45.1	43.7	0.9731	0.9724	0.7716	0.9708	0.9699
20-24	85.2	86.8	88.3	89.7	91.0	92.2	93.3	1.0188	1.0173	1.0159	1.0145	1.0132
25-29	93.7	96.0	97.5	98.5	99.1	99.5	99.7	1.0245	1.1560	1.0103	1.0061	1.0040
30-34	95.1	97.1	98.3	99.0	99.4	99.6	99.7	1.0210	1.0124	1.0071	1.0040	1.0020
35-39	95.8	97.2	98.2	98.9	99.3	99.6	99.8	1.0146	1.0103	1.0071	1.0040	1.0030
40-44	95.9	97.1	98.0	98.6	99.0	99.3	99.5	1.0125	1.0093	1.0061	1.0041	1.0030
45-49	95.5	96.7	97.6	98.3	98.8	99.2	99.5	1.0126	1.0093	1.0072	1.0051	1.0040
50-54	93.8	95.1	96.2	97.1	97.8	98.3	98.7	1.0139	1.0116	1.0094	1.0072	1.0051
55-59	88.7	89.5	90.3	91.0	91.7	92.4	93.0	1.0090	1.0089	1.0078	1.0077	1.0076
60-64	81.5	81.9	82.3	82.7	83.1	83.5	83.9	1.0049	1.0049	1.0049	1.0048	1.0048
65 and over	55.7	54.5	53.3	52.1	50.9	49.7	48.5	0.9785	0.9780	0.9775	0.9770	0.9764
<i>Females</i>												
15-19	48.3	48.9	49.5	50.1	50.7	51.3	51.9	1.0124	1.0123	1.0121	1.0120	1.0118
20-24	66.6	68.4	70.2	72.0	73.8	75.6	77.4	1.0270	1.0263	1.0256	1.0250	1.0244
25-29	51.5	50.1	48.7	47.3	45.9	44.6	43.3	0.9728	0.9721	0.9713	0.9704	0.9717
30-34	49.1	50.7	52.3	53.9	55.5	57.2	58.9	1.0326	1.0316	1.0306	1.0297	1.0306
35-39	52.4	54.4	56.5	58.7	61.0	63.3	65.6	1.0382	1.0386	1.0389	1.0392	1.0377
40-44	55.3	57.0	58.7	60.4	62.1	63.8	65.5	1.0307	1.0298	1.0290	1.0281	1.0274
45-49	54.2	56.5	58.9	61.4	63.9	66.5	69.1	1.0424	1.0425	1.0424	1.0407	1.0407
50-54	50.5	51.9	53.3	54.7	56.1	57.6	59.1	1.0277	1.0270	1.0263	1.0256	1.0267
55-59	45.9	45.8	45.7	45.6	45.5	45.4	45.3	0.9978	0.9978	0.9978	0.9978	0.9978
60-64	39.1	39.1	39.1	39.1	39.1	39.1	39.1	1.0000	1.0000	1.0000	1.0000	1.0000
65 and over	21.1	21.4	21.7	22.0	22.3	22.6	22.9	1.0142	1.0140	1.0138	1.0136	1.0135

ANNEX II (continued)

Sex and age	Increase (decrease)					Increase (decrease) multiplied by the correction coefficient				
	1960/1955	1965/1960	1970/1965	1975/1970	1980/1975	1960/1955	1965/1960	1970/1965	1975/1970	1980/1975
(1)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)
<i>Males</i>										
15-19	-0.0269	-0.0276	-0.0284	-0.0292	-0.0301	-0.0269	-0.0282	-0.0284	-0.0291	-0.0300
20-24	0.0188	0.0173	0.0159	0.0145	0.0132	0.0171	0.0156	0.0142	0.0129	0.0115
25-29	0.0245	0.0156	0.103	0.0061	0.0040	0.0159	0.0099	0.0062	0.0037	0.0022
30-34	0.0210	0.0124	0.0071	0.0040	0.0020	0.0127	0.0074	0.0042	0.0024	0.0013
35-39	0.0146	0.0103	0.0071	0.0040	0.0030	0.0099	0.0067	0.0044	0.0026	0.0017
40-44	0.0125	0.0093	0.0061	0.0041	0.0030	0.0090	0.0065	0.0043	0.0029	0.0021
45-49	0.0126	0.0093	0.0072	0.0051	0.0040	0.0094	0.0068	0.0051	0.0036	0.0027
50-54	0.0139	0.0116	0.0094	0.0072	0.0051	0.0111	0.0091	0.0072	0.0055	0.0040
55-69	0.0090	0.0089	0.0078	0.0077	0.0076	0.0084	0.0083	0.0073	0.0072	0.0070
60-64	0.0049	0.0049	0.0049	0.0048	0.0048	0.0048	0.0048	0.0048	0.0047	0.0047
65 and over	-0.0215	-0.0220	-0.0225	-0.0230	-0.0236	-0.0216	-0.0221	-0.0226	-0.0230	-0.0236
<i>Females</i>										
15-19	0.0124	0.0123	0.0121	0.0120	0.0118	0.0124	0.0123	0.0121	0.0120	0.0118
20-24	0.0270	0.0263	0.0256	0.0250	0.0244	0.0262	0.0255	0.0247	0.0240	0.0233
25-29	-0.0272	-0.0279	-0.0287	-0.0296	-0.0283	-0.0272	-0.0279	-0.0286	-0.0285	-0.0282
30-34	0.0326	0.0316	0.0306	0.0297	0.0306	0.0326	0.0315	0.0305	0.0303	0.0303
35-39	0.0382	0.0386	0.0389	0.0392	0.0377	0.0380	0.0382	0.0384	0.0377	0.0368
40-44	0.0307	0.0298	0.0290	0.0281	0.0274	0.0304	0.0295	0.0286	0.0281	0.0269
45-49	0.0424	0.0425	0.0424	0.0407	0.0407	0.0420	0.0419	0.0415	0.0404	0.0393
50-54	0.0277	0.0270	0.0263	0.0256	0.0267	0.0277	0.0269	0.0262	0.0260	0.0265
55-59	-0.0022	-0.0022	-0.0022	-0.0022	-0.0022	-0.0022	-0.0022	-0.0022	-0.0022	-0.0022
60-64	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
65 and over	0.0142	0.0140	0.0138	0.0126	0.0135	0.0143	0.0141	0.0139	0.0140	0.0136

ANNEX II (continued)

Sex and age (1)	Product of activity rates and inactivity rates						Correction coefficient				
	1955 (24)	1960 (25)	1965 (26)	1970 (27)	1975 (28)	1980 (29)	1960/1955 (30)	1965/1960 (31)	1970/1965 (32)	1975/1970 (33)	1980/1975 (34)
<i>Males</i>											
15-19	2,495.59	2,449.51	2,499.51	2,495.59	2,487.75	2,475.99	1.00157	1.02041	0.99843	0.99685	0.99527
20-24	1,260.91	1,145.76	1,033.11	923.91	819.00	719.16	0.90864	0.90168	0.89429	0.88644	0.87809
25-29	590.31	384.00	243.75	147.75	89.19	49.75	0.65050	0.63476	0.60615	0.60365	0.55779
30-34	465.99	281.59	167.11	99.00	59.64	39.84	0.60428	0.59345	0.59242	0.60242	0.66800
35-39	402.36	272.16	176.76	108.79	69.51	39.84	0.67640	0.64947	0.61546	0.63893	0.57315
40-44	393.79	281.59	196.00	138.04	99.00	69.51	0.71617	0.69604	0.70428	0.71718	0.70212
45-49	429.75	319.11	234.24	167.11	118.56	79.36	0.74254	0.73404	0.71341	0.70947	0.66936
50-54	581.56	465.99	365.56	281.59	215.16	267.11	0.80127	0.78448	0.77029	0.76408	0.77667
55-59	1,002.31	939.75	875.91	819.00	761.11	702.24	0.93755	0.93206	0.93502	0.92931	0.92265
60-64	1,507.75	1,482.39	1,456.71	1,430.71	1,404.39	1,377.75	0.98318	0.98267	0.98215	0.98160	0.98103
65 and over	2,467.51	2,479.75	2,489.11	2,495.59	2,499.19	2,499.91	1.00496	1.00377	1.00260	1.00144	0.00028
<i>Females</i>											
15-19	2,497.11	2,498.79	2,499.75	2,499.99	2,499.51	2,498.31	1.00067	1.00038	1.00009	0.99980	0.99951
20-24	2,224.44	2,161.44	2,091.96	2,016.00	1,933.56	1,844.64	0.97168	0.96785	0.96368	0.95910	0.95401
25-29	2,497.75	2,499.99	2,498.31	2,492.71	2,483.19	2,470.84	1.00090	0.99932	0.99775	0.99618	0.99502
30-34	2,499.19	2,499.51	2,494.71	2,484.78	2,469.75	2,448.16	1.00013	0.99807	0.99602	0.99394	0.99125
35-39	2,494.24	2,480.64	2,457.75	2,424.31	2,379.00	2,323.11	0.99455	0.99077	0.98639	0.98131	0.97650
40-44	2,471.91	2,451.00	2,424.31	2,391.84	2,353.59	2,309.56	0.99154	0.98911	0.98660	0.98400	0.98129
45-49	2,482.36	2,457.75	2,420.79	2,370.04	2,306.79	2,227.75	0.99009	0.98496	0.97903	0.97331	0.96573
50-54	2,499.75	2,496.39	2,489.11	2,477.91	2,462.79	2,442.24	0.99866	0.99708	0.99550	0.99389	0.99165
55-59	2,483.19	2,482.36	2,481.51	2,480.64	2,479.75	2,478.84	0.99967	0.99965	0.99964	0.99964	0.99963
60-64	2,381.19	2,381.19	2,381.19	2,381.19	2,381.19	2,381.19	1.00000	1.00000	1.00000	1.00000	1.00000
65 and over	1,664.79	1,682.04	1,699.11	1,716.00	1,732.71	1,749.74	1.01036	1.01014	1.00994	1.00973	1.00982

ANNEX II (concluded)

Sex and age (1)	Adjusted ratio of increase (or decrease)				
	1960/1955 (35)	1965/1960 (36)	1970/1965 (37)	1975/1970 (38)	1980/1975 (39)
<i>Males</i>					
15-19	0.9731	0.9718	0.9716	0.9709	0.9700
20-24	1.0171	1.0156	1.0142	1.0129	1.0115
25-29	1.0159	1.0099	1.0062	1.0037	1.0022
30-34	1.0127	1.0074	1.0042	1.0024	1.0013
35-39	1.0099	1.0067	1.0044	1.0026	1.0017
40-44	1.0090	1.0065	1.0043	1.0029	1.0021
45-49	1.0094	1.0068	1.0051	1.0036	1.0027
50-54	1.0111	1.0091	1.0072	1.0055	1.0040
55-59	1.0084	1.0081	1.0073	1.0072	1.0070
60-64	1.0048	1.0048	1.0048	1.0047	1.0047
65 and over	0.9784	0.9779	0.9774	0.9770	0.9764
<i>Females</i>					
15-19	1.0124	1.0123	1.0212	1.0120	1.0118
20-24	1.0262	1.0255	1.0247	1.0240	1.0233
25-29	0.9728	0.9721	0.9714	0.9715	0.9718
30-34	1.0326	1.0315	1.0305	1.0303	1.0303
35-39	1.0380	1.0382	1.0384	1.0377	1.0368
40-44	1.0304	1.0295	1.0286	1.0281	1.0269
45-49	1.0420	1.0419	1.0415	1.0404	1.0393
50-54	1.0277	1.0269	1.0262	1.0260	1.0265
55-59	0.9978	0.9978	0.9978	0.9978	0.9978
60-64	1.0000	1.0000	1.0000	1.0000	1.0000
65 and over	1.0143	1.0141	1.0139	1.0140	1.0136

^a Computations:

- (4) = (3) × (35)
- (5) = (4) × (36)
- (6) = (5) × (37)
- (7) = (6) × (38)
- (8) = (7) × (39)
- (9) = (3) : (2)
- (10) = (4) : (3)
- (11) = (5) : (4)
- (12) = (6) : (5)
- (13) = (7) : (6)
- (14) = (9) - 1
- (15) = (10) - 1
- (16) = (11) - 1
- (17) = (12) - 1
- (18) = (13) - 1
- (19) = (14) × (30)
- (20) = (15) × (31)

- (21) = (16) × (32)
- (22) = (17) × (33)
- (23) = (18) × (34)
- (24) = (2) × [100 - (2)]
- (25) = (3) × [100 - (3)]
- (26) = (4) × [100 - (4)]
- (27) = (5) × [100 - (5)]
- (28) = (6) × [100 - (6)]
- (29) = (7) × [100 - (7)]
- (30) = (25) : (24)
- (31) = (26) : (25)
- (32) = (27) : (26)
- (33) = (28) : (27)
- (34) = (29) : (28)
- (35) = 1 + (19)
- (36) = 1 + (20)
- (37) = 1 + (21)
- (38) = 1 + (22)
- (39) = 1 + (23)

ANNEX III

Japan: projection of sex-age-specific activity rates of the population, 1965-1985 simple direct extrapolation for each age group^a

Sex and age	Activity rates							Increase (decrease) in activity rates				
	Observed		Projected									
	1955	1960	1965	1970	1975	1980	1985	1960/1965	1965/1960	1970/1965	1975/1970	1980/1975
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
<i>Males</i>												
15-19	52.1	50.7	49.3	47.9	46.5	45.1	43.7	0.0731	0.9724	0.9716	0.9708	0.9699
20-24	85.2	96.8	88.4	90.0	91.6	93.2	94.8	1.0188	1.0184	1.0181	1.0178	1.0175
25-29	93.7	96.0	98.4	100.9	103.5	106.2	109.0	1.0245	1.0250	1.0254	1.0258	1.0261
30-34	95.1	97.1	99.1	101.1	103.1	105.1	107.1	1.0210	1.0206	1.0202	1.0198	1.0194
35-39	95.8	97.2	98.6	100.0	101.4	102.8	104.2	1.0146	1.0144	1.0142	1.0140	1.0138
40-44	95.9	97.1	98.3	99.5	100.7	101.9	103.1	1.0125	1.0124	1.0122	1.0121	1.0119
45-49	95.5	96.7	97.9	99.1	100.3	101.5	102.7	1.0126	1.0124	1.0123	1.0121	1.0120
50-54	93.8	95.1	96.4	97.7	99.0	100.3	101.6	1.0139	1.0137	1.0135	1.0133	1.0131
55-59	88.7	89.5	90.3	91.1	91.9	92.7	93.5	1.0090	1.0089	1.0089	1.0088	1.0087
60-64	81.5	81.9	82.3	82.7	83.1	83.5	83.9	1.0049	1.0049	1.0049	1.0048	1.0048
65 and over	55.7	54.5	53.3	52.1	50.9	49.7	48.5	0.9785	0.9780	0.9775	0.9770	0.9764
<i>Females</i>												
15-19	48.3	48.9	49.5	50.1	50.7	51.3	51.9	1.0124	1.0123	1.0121	1.0120	1.0118
20-24	66.6	68.4	70.2	72.0	73.8	75.6	77.4	1.0270	1.0263	1.0256	1.0250	1.0244
25-29	51.5	50.1	48.7	47.3	45.9	44.5	43.1	0.9728	0.9721	0.9713	0.9704	0.9695
30-34	49.1	50.7	52.4	54.2	56.1	58.1	60.2	1.0326	1.0335	1.0344	1.0351	1.0357
35-39	52.4	54.4	56.5	58.7	61.0	63.4	65.9	1.0382	1.0386	1.0389	1.0392	1.0393
40-44	55.3	57.0	58.7	60.4	62.2	64.1	66.1	1.0307	1.0298	1.0290	1.0298	1.0305
45-49	54.2	56.5	58.9	61.4	64.0	66.7	69.5	1.0424	1.0425	1.0424	1.0423	1.0422
50-54	50.5	51.9	53.3	54.7	56.1	57.5	58.9	1.0277	1.0270	1.0263	1.0256	1.0250
55-59	45.9	45.8	45.7	45.6	45.5	45.4	45.3	0.9978	0.9978	0.9978	0.9978	0.9978
60-64	39.1	39.1	39.1	39.1	39.1	39.1	39.1	1.0000	1.0000	1.0000	1.0000	1.0000
65 and over	21.1	21.4	21.7	22.0	22.3	22.6	22.9	1.0142	1.0140	1.0138	1.0136	1.0135

^a Computations:

(4) = (3) × (9)
 (5) = (4) × (10)
 (6) = (5) × (11)
 (7) = (6) × (12)
 (8) = (7) × (13)

(9) = (3) : (2)
 (10) = (4) : (3)
 (11) = (5) : (4)
 (12) = (6) : (5)
 (13) = (7) : (6)

ANNEX IV

Japan: projection of sex-age-specific activity rates of the population, 1965-1985: indirect extrapolation with correction coefficient^a

Sex and age	Inactivity rates							Activity rates				
	Observed		Projected					Projected				
	1955	1960	1965	1970	1975	1980	1985	1965	1970	1975	1980	1985
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
<i>Males</i>												
15-19	47.9	49.3	50.7	52.1	53.5	54.9	56.3	49.3	47.9	46.5	45.1	43.7
20-24	14.8	13.2	11.9	10.8	9.9	9.1	8.4	83.1	89.2	90.1	90.9	91.6
25-29	6.3	4.0	3.1	2.6	2.2	1.9	1.7	96.9	97.4	97.8	98.1	98.3
30-34	4.9	2.9	2.2	1.8	1.5	1.3	1.1	97.8	98.2	98.5	98.7	98.9
35-39	4.2	2.8	2.2	1.8	1.5	1.3	1.1	97.8	98.2	98.5	98.7	98.9
40-44	4.1	2.9	2.3	1.9	1.6	1.4	1.2	97.7	98.1	98.4	98.6	98.8
45-49	4.5	3.3	2.6	2.2	1.9	1.7	1.5	97.4	97.8	98.1	98.3	98.5
50-54	6.2	4.9	4.1	3.5	3.1	2.8	2.6	95.9	96.5	96.9	97.2	97.4
55-59	11.3	10.5	9.8	9.2	8.7	8.2	7.8	90.2	90.8	91.3	91.8	92.2
60-64	18.5	18.1	17.7	17.3	16.9	16.4	15.9	82.3	82.7	83.1	83.6	84.1
65 and over	44.3	45.5	46.7	47.9	49.1	50.3	51.6	53.3	52.1	50.9	49.7	48.4
<i>Females</i>												
15-19	51.7	51.1	50.5	49.9	49.3	48.7	48.1	49.5	50.1	50.7	51.3	51.9
20-24	33.4	31.6	29.9	28.3	26.8	25.4	24.1	70.1	71.7	73.2	74.6	75.9
25-29	48.5	49.9	51.3	49.9	48.5	47.1	45.7	48.7	50.1	51.5	52.9	54.3
30-34	50.9	49.3	47.8	45.9	49.1	42.4	40.8	52.2	54.1	55.9	57.6	59.2
35-39	47.6	45.6	43.7	41.9	40.2	38.6	37.1	56.3	58.1	59.8	61.4	62.9
40-44	44.7	43.0	41.4	39.9	38.5	37.2	36.0	58.6	60.1	61.5	62.8	64.0
45-49	45.8	43.5	41.3	39.2	37.2	35.3	33.5	58.7	60.8	62.8	64.7	66.5
50-54	49.5	48.1	46.7	45.3	43.9	42.6	41.3	53.3	54.7	56.1	57.4	58.7
55-59	54.1	54.2	54.3	54.4	54.5	54.6	54.7	45.7	45.6	45.5	45.4	45.3
60-64	60.9	60.9	60.9	60.9	60.9	60.9	60.9	39.1	39.1	39.1	39.1	39.1
65 and over	78.9	78.6	78.3	78.0	77.7	77.4	77.1	21.7	22.0	22.3	22.6	22.9

ANNEX IV (continued)

Sex and age	Ratio of increase (or decrease)					Increase (decrease)					Product of increase (decrease) and correction coefficient				
	1960/1955	1965/1960	1970/1965	1975/1970	1980/1975	1960/1955	1965/1960	1970/1965	1975/1970	1980/1975	1960/1955	1965/1960	1970/1965	1975/1970	1980/1975
(1)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)	(27)	(28)
<i>Males</i>															
15-19	1.0292	1.0284	1.0276	1.0269	1.0262	0.0292	0.0284	0.0276	0.0269	0.0262	0.0292	0.0284	0.0276	0.0268	0.0261
20-24	0.8919	0.9015	0.9076	0.9167	0.9192	-0.1081	-0.0985	-0.0924	-0.0833	-0.0808	-0.0982	-0.0901	-0.0849	-0.0771	-0.0749
25-29	0.6349	0.7750	0.8387	0.8462	0.8636	-0.3651	-0.2250	-0.1613	-0.1538	-0.1364	-0.2375	-0.1760	-0.1360	-0.1307	-0.1182
30-34	0.5918	0.7586	0.8182	0.8333	0.8667	-0.4082	-0.2414	-0.1818	-0.1667	-0.1333	-0.2467	-0.1844	-0.1494	-0.1393	-0.1158
35-39	0.6667	0.7857	0.8182	0.8333	0.8667	-0.3333	-0.2143	-0.1818	-0.1667	-0.1333	-0.2254	-0.1694	-0.1494	-0.1393	-0.1158
40-44	0.7073	0.7931	0.8261	0.8421	0.8750	-0.2927	-0.2069	-0.1739	-0.1579	-0.1250	-0.2096	-0.1798	-0.1325	-0.1334	-0.1096
45-49	0.7333	0.7879	0.8462	0.8636	0.8947	-0.2667	-0.2121	-0.1538	-0.1364	-0.1053	-0.1980	-0.1683	-0.1307	-0.1182	-0.0944
50-54	0.7903	0.8367	0.8537	0.8857	0.9032	-0.2907	-0.1633	-0.1463	-0.1143	-0.9068	-0.1680	-0.1370	-0.1257	-0.1017	-0.0877
55-59	0.9292	0.9333	0.9388	0.9457	0.9425	-0.0708	-0.0667	-0.0612	-0.0643	-0.0575	-0.0664	-0.0627	-0.0578	-0.0611	-0.0545
60-64	0.9784	0.9779	0.9774	0.9769	0.9704	-0.0216	-0.0221	-0.0226	-0.0331	-0.0296	-0.0212	-0.0217	-0.0222	-0.0325	-0.0289
65 and over . .	1.0271	1.0264	1.0257	1.0251	1.0244	0.0271	0.0264	0.0257	0.0251	0.0251	0.0272	0.0265	0.0258	0.0251	0.0251
<i>Females</i>															
15-19	0.9884	0.9883	0.9881	0.9880	0.9878	-0.0116	-0.0117	-0.0119	-0.0120	-0.0122	-0.0116	-0.0117	-0.0119	-0.0120	-0.0122
20-24	0.9461	0.9462	0.9465	0.9470	0.9478	-0.0539	-0.0538	-0.0535	-0.0530	-0.0522	-0.0524	-0.0522	-0.0518	-0.0512	-0.0504
25-29	1.0289	1.0281	0.9727	0.9719	0.9711	0.0289	0.0281	0.0283	0.0281	0.0289	0.0289	0.0281	0.0273	0.0281	0.0288
30-34	0.9686	0.9696	0.9603	0.9608	0.9615	-0.0314	-0.0304	-0.0397	-0.0392	-0.0385	-0.0314	-0.0303	-0.0395	-0.0389	-0.0381
35-39	0.9580	0.9583	0.9588	0.9594	0.9602	-0.0420	-0.0417	-0.0412	-0.0406	-0.0398	-0.0418	-0.0414	-0.0408	-0.0401	-0.0392
40-44	0.9620	0.9628	0.9638	0.9649	0.9662	-0.0380	-0.0372	-0.0362	-0.0351	-0.0338	-0.0377	-0.0368	-0.0358	-0.0347	-0.0333
45-49	0.9498	0.9494	0.9492	0.9490	0.9489	-0.0502	-0.0506	-0.0508	-0.0510	-0.0511	-0.0497	-0.0499	-0.0499	-0.0500	-0.0500
50-54	0.9717	0.9709	0.9700	0.9691	0.9704	-0.0283	-0.0291	-0.0300	-0.0309	-0.0296	-0.0283	-0.0290	-0.0299	-0.0307	-0.0294
55-59	1.0018	1.0018	1.0018	1.0018	1.0018	0.0018	0.0018	0.0018	0.0018	0.0018	0.0018	0.0018	0.0018	0.0018	0.0018
60-64	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
65 and over . .	0.9962	0.9962	0.9962	0.9962	0.9961	-0.0038	-0.0038	-0.0038	-0.0038	-0.0039	-0.0038	-0.0038	-0.0038	-0.0038	-0.0039

ANNEX IV (continued)

Sex and age (1)	Adjusted ratio of increase (decrease)					Correction coefficient				
	1960/1955 (29)	1965/1960 (30)	1970/1965 (31)	1975/1970 (32)	1980/1975 (33)	1960/1955 (34)	1965/1960 (35)	1970/1965 (36)	1975/1970 (37)	1980/1975 (38)
Males										
15-19	1.0292	1.0284	1.0276	1.0268	1.0261	1.00157	1.00000	0.99843	0.99685	0.99527
20-24	0.9018	0.9099	0.9151	0.9229	0.9251	0.90964	0.91501	0.91889	0.92591	0.92735
25-29	0.7625	0.8240	0.8640	0.8693	0.8818	0.65050	0.78226	0.84303	0.84962	0.86628
30-34	0.7533	0.8156	0.8706	0.8506	0.8842	0.60428	0.76408	0.82152	0.83587	0.86842
35-39	0.7746	0.8306	0.8506	0.8607	0.8842	0.67640	0.79056	0.82152	0.83587	0.86842
40-44	0.7904	0.8202	0.8675	0.8666	0.8914	0.71617	0.86902	0.76167	0.84468	0.87677
45-49	0.8020	0.8317	0.8693	0.8818	0.9056	0.74254	0.79358	0.84962	0.86628	0.89656
50-54	0.8320	0.8622	0.8743	0.8983	0.9123	0.80127	0.84377	0.85899	0.88938	0.90602
55-59	0.9336	0.9373	0.9422	0.9389	0.9955	0.93758	0.94063	0.94502	0.95085	0.94769
60-64	0.9788	0.9783	0.9778	0.9675	0.9711	0.98318	0.98267	0.98215	0.98160	0.97625
65 and over	1.0272	1.0265	1.0258	1.0251	1.0251	1.00486	1.00377	1.00260	1.00144	1.00028
Females										
15-19	0.9884	0.9883	0.9881	0.9880	0.9878	1.00067	1.00038	1.00009	0.99980	0.99951
20-24	0.9476	0.9478	0.9482	0.9488	0.9496	0.97168	0.96871	0.96809	0.96680	0.96588
25-29	1.0289	0.9719	0.9727	0.9719	0.9712	1.00090	0.99932	1.00067	0.99910	0.99753
30-34	0.9686	0.9607	0.9605	0.9611	0.9619	1.00013	0.99825	0.99520	0.99275	0.99069
35-39	0.9582	0.9586	0.9592	0.9599	0.9608	0.99455	0.99180	0.98946	0.98749	0.98588
40-44	0.9623	0.9632	0.9642	0.9653	0.9667	0.99154	0.98981	0.98843	0.98738	0.98665
45-49	0.9503	0.9501	0.9501	0.9500	0.9500	0.99009	0.98639	0.98310	0.98019	0.97763
50-54	0.9717	0.9710	0.9701	0.9693	0.9706	0.99866	0.99708	0.99550	0.99389	0.99287
55-59	1.0018	1.0018	1.0018	1.0018	1.0018	0.99967	0.99965	0.99964	0.99964	0.99963
60-64	1.0000	1.0000	1.0000	1.0000	1.0000	1.00000	1.00000	1.00000	1.00000	1.00000
65 and over	0.9962	0.9962	0.9962	0.9962	0.9961	1.01036	1.01014	1.00994	1.00973	1.00953

ANNEX IV (concluded)

Sex and age (1)	Product of activity rates and inactivity rates					
	1955 (39)	1960 (40)	1965 (41)	1970 (42)	1975 (43)	1980 (44)
Males						
15-19	2,495.59	2,499.51	2,499.51	2,495.59	2,487.75	2,475.99
20-24	1,260.96	1,145.76	1,048.39	963.36	891.99	827.19
25-29	590.31	384.00	300.39	253.24	215.16	186.39
30-34	465.99	281.59	215.16	176.76	147.75	128.31
35-39	402.36	272.16	215.16	176.76	147.75	128.31
40-44	393.19	281.59	244.71	186.39	157.44	138.04
45-49	429.75	319.11	253.24	215.16	186.39	167.11
50-54	581.56	465.99	393.19	337.75	300.39	272.16
55-59	1,002.31	939.75	883.96	835.36	794.31	752.76
60-64	1,507.75	1,482.39	1,456.71	1,430.71	1,404.39	1,371.04
65 and over	2,467.51	2,479.75	2,489.11	2,495.59	2,499.19	2,499.91
Females						
15-19	2,497.11	2,498.79	2,499.75	2,499.99	2,499.51	2,498.31
20-24	2,224.44	2,161.44	2,095.99	2,029.11	1,961.76	1,894.84
25-29	2,497.75	2,499.99	2,498.31	2,494.99	2,497.75	2,491.59
30-34	2,499.19	2,499.51	2,495.16	2,483.19	2,465.19	2,442.24
35-39	2,494.24	2,480.64	2,460.31	2,439.39	2,403.96	2,370.04
40-44	2,471.91	2,451.00	2,426.04	2,397.99	2,367.75	2,336.16
45-49	2,482.36	2,457.75	2,424.31	2,383.36	2,336.16	2,283.91
50-54	2,499.75	2,496.39	2,498.11	2,477.91	2,462.79	2,445.24
55-59	2,483.19	2,482.36	2,481.51	2,480.64	2,479.75	2,478.84
60-64	2,381.19	2,381.19	2,381.19	2,381.19	2,381.19	2,381.19
65 and over	1,664.79	1,682.04	1,699.11	1,716.00	1,732.71	1,749.24

* Computations:

(4) = (3) × (29)
 (5) = (4) × (30)
 (6) = (5) × (31)
 (7) = (6) × (32)
 (8) = (7) × (33)
 (9) = 100 - (4)
 (10) = 100 - (5)
 (11) = 100 - (6)
 (12) = 100 - (7)
 (13) = 100 - (8)
 (14) = (3) : (2)
 (15) = (4) : (3)
 (16) = (5) : (4)
 (17) = (6) : (5)
 (18) = (7) : (6)
 (19) = (14) - 1
 (20) = (15) - 1
 (21) = (16) - 1
 (22) = (17) - 1
 (23) = (18) - 1

(24) = (19) × (34)
 (25) = (20) × (35)
 (26) = (21) × (36)
 (27) = (22) × (37)
 (28) = (23) × (38)
 (29) = (24) + 1
 (30) = (25) + 1
 (31) = (26) + 1
 (32) = (27) + 1
 (33) = (28) + 1
 (34) = (40) : (39)
 (35) = (41) : (40)
 (36) = (42) : (41)
 (37) = (43) : (42)
 (38) = (44) : (43)
 (39) = (2) × [100 - (2)]
 (40) = (3) × [100 - (3)]
 (41) = (4) × [100 - (4)]
 (42) = (5) × [100 - (5)]
 (43) = (6) × [100 - (6)]
 (44) = (7) × [100 - (7)]

ANNEX V

Japan: projection of sex-age-specific activity rates of the population, 1965-1985: simple indirect extrapolation for each age group ^a

Sex and age (1)	Inactivity rates		Projected activity rates					Ratio of increase (or decrease)				
	1955 (2)	1960 (3)	1965 (4)	1970 (5)	1975 (6)	1980 (7)	1985 (8)	1960/1955 (9)	1965/1960 (10)	1970/1965 (11)	1975/1970 (12)	1980/1975 (13)
<i>Males</i>												
15-19	47.9	49.3	49.3	47.9	46.5	45.1	43.7	1.0292	1.0284	1.0276	1.0269	1.0262
20-24	14.8	13.2	88.2	89.5	90.7	91.8	92.8	0.8919	0.8939	0.8898	0.8857	0.8817
25-29	6.3	4.0	97.5	98.4	99.0	99.4	99.6	0.6349	0.6250	0.6400	0.6259	0.6000
30-34	4.9	2.9	98.3	99.0	99.4	99.6	99.7	0.5918	0.5862	0.5882	0.6000	0.6667
35-39	4.2	2.8	98.1	98.7	99.1	99.4	99.6	0.6667	0.6786	0.6842	0.6923	0.6667
40-44	4.1	2.9	97.9	98.5	98.9	99.2	99.4	0.7073	0.7241	0.7143	0.7333	0.7273
45-49	4.5	3.3	97.6	98.3	98.8	99.2	99.5	0.7333	0.7273	0.7083	0.7059	0.6667
50-54	6.2	4.9	96.1	96.9	97.5	98.0	98.4	0.7903	0.7959	0.7949	0.8065	0.8000
55-59	11.3	10.5	90.2	90.9	91.5	92.1	92.7	0.9292	0.9333	0.9286	0.9341	0.9294
60-64	18.5	18.1	82.3	82.7	83.1	83.5	83.9	0.9784	0.9779	0.9774	0.9769	0.9763
65 and over	44.3	45.5	53.3	52.1	50.9	49.3	48.5	1.0271	1.0264	1.0257	1.0251	1.0244
<i>Females</i>												
15-19	51.7	51.1	49.5	50.1	50.7	51.3	51.9	0.9884	0.9883	0.9881	0.9880	0.9878
20-24	33.4	31.6	70.1	71.7	73.2	74.6	75.9	0.9461	0.9462	0.9465	0.9470	0.9478
25-29	48.5	49.9	48.7	47.3	45.9	44.5	43.1	1.0289	1.0281	1.0273	1.0266	1.0259
30-34	50.9	49.3	52.2	53.7	55.2	56.7	58.2	0.9686	0.9696	0.9686	0.9676	0.9665
35-39	47.6	45.6	56.3	58.1	59.8	61.4	62.9	0.9580	0.9583	0.9588	0.9594	0.9602
40-44	44.7	43.0	58.6	60.1	61.5	63.8	64.1	0.9620	0.9628	0.9638	0.9649	0.9662
45-49	45.8	43.5	58.7	60.8	62.8	64.7	66.5	0.9498	0.9494	0.9492	0.9490	0.9489
50-54	49.5	48.1	53.3	54.7	56.1	57.5	58.9	0.9717	0.9709	0.9700	0.9691	0.9681
55-59	54.1	54.2	45.7	45.6	45.5	45.4	45.3	1.0018	1.0018	1.0018	1.0018	1.0018
60-64	60.9	60.9	39.1	39.1	39.1	39.1	39.1	1.0000	1.0000	1.0000	1.0000	1.0000
65 and over	78.9	78.6	21.7	22.0	22.3	22.6	22.9	0.9962	0.9962	0.9962	0.9962	0.9961

^a Computations:

$$\begin{aligned}
 (4) &= 100 - [(3) \times (9)] \\
 (5) &= 100 - [(4) \times (10)] \\
 (6) &= 100 - [(5) \times (11)] \\
 (7) &= 100 - [(6) \times (12)] \\
 (8) &= 100 - [(7) \times (13)]
 \end{aligned}$$

$$\begin{aligned}
 (9) &= 100 - (3) : (2) \\
 (10) &= 100 - (4) : 100 - (3) \\
 (11) &= 100 - (5) : 100 - (4) \\
 (12) &= 100 - (6) : 100 - (5) \\
 (13) &= 100 - (7) : 100 - (6)
 \end{aligned}$$

ANNEX VI

Japan: projection of the sex-age-specific activity rates of the population, 1965-1985: extrapolation by cohort with correction coefficient ^a

Sex and age	Activity rates							Cohort ratio				
	Observed		Projected ^a									
	1955	1960	1965	1970	1975	1980	1985	1960/1955	1965/1960	1970/1965	1975/1970	1980/1975
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Males												
15-19	52.1	50.7	—	—	—	—	—	—	—	—	—	—
20-24	85.2	86.8	81.4	—	—	—	—	1.666	1.606	—	—	—
25-29	93.7	96.0	94.0	91.3	—	—	—	1.127	1.083	1.122	—	—
30-34	95.1	97.1	98.1	95.4	94.5	—	—	1.036	1.022	1.015	1.035	—
35-39	95.8	97.2	98.6	98.9	96.0	96.5	—	1.022	1.015	1.008	1.006	1.021
40-44	95.9	97.1	98.2	99.2	99.2	96.3	97.8	1.014	1.010	1.006	1.003	1.003
45-49	95.5	96.7	97.7	98.6	99.4	99.3	96.4	1.008	1.006	1.004	1.002	1.001
50-54	93.8	95.1	16.4	97.5	98.5	99.3	99.3	0.996	0.997	0.998	0.999	0.999
55-59	88.7	89.5	91.0	92.8	94.6	96.2	97.7	0.954	0.957	0.963	0.970	0.977
60-64	81.5	81.9	82.7	84.4	86.6	89.0	91.4	0.923	0.924	0.927	0.933	0.941
65 and over	55.7	54.5	54.6	55.2	56.4	58.0	59.9	0.669	0.667	0.677	0.668	0.670
Females												
15-19	48.3	48.9	—	—	—	—	—	—	—	—	—	—
20-24	66.6	68.4	68.7	—	—	—	—	1.416	1.405	—	—	—
25-29	51.5	50.1	51.4	51.6	—	—	—	0.752	0.751	0.751	—	—
30-34	49.1	50.7	49.3	50.6	50.8	—	—	0.984	0.984	0.984	0.984	—
35-39	52.9	54.4	56.1	54.5	56.0	56.2	—	1.108	1.107	1.105	1.107	1.106
40-44	55.3	57.0	59.1	60.9	59.1	60.8	61.0	1.088	1.086	1.086	1.084	1.086
45-49	54.2	56.5	58.3	60.5	62.4	60.6	62.3	1.022	1.023	1.024	1.025	1.025
50-54	50.5	51.9	54.1	55.9	58.0	59.8	58.1	0.958	0.958	0.959	0.955	0.958
55-59	45.9	45.8	47.1	49.1	50.8	52.7	54.4	0.907	0.908	0.908	0.909	0.909
60-64	39.1	39.1	39.0	40.1	41.7	43.1	44.6	0.852	0.852	0.851	0.849	0.848
65 and over	21.1	21.4	21.2	21.3	21.8	22.4	22.8	0.547	0.542	0.546	0.544	0.537

ANNEX VI (continued)

Sex and age (1)	Increase (decrease) in the cohort ratio					Product of increase (decrease) in the cohort ratio and correction coefficient					Adjusted cohort ratio				
	1960/1955 (14)	1965/1960 (15)	1970/1965 (16)	1975/1970 (17)	1980/1975 (18)	1960/1955 (19)	1965/1960 (20)	1970/1965 (21)	1975/1970 (22)	1980/1975 (23)	1960/1955 (24)	1965/1960 (25)	1970/1965 (26)	1975/1970 (27)	1980/1975 (28)
<i>Males</i>															
15-19	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
20-24	0.666	0.606	—	—	—	0.605	0.801	—	—	—	1.605	1.801	—	—	—
25-29	0.127	0.083	0.122	—	—	0.083	0.122	0.172	—	—	1.083	1.122	1.172	—	—
30-34	0.036	0.022	0.015	0.035	—	0.022	0.015	0.035	0.041	—	1.022	1.015	1.035	1.041	—
35-39	0.022	0.015	0.008	0.006	0.021	0.015	0.008	0.006	0.021	0.018	1.015	1.008	1.006	1.021	1.018
40-44	0.014	0.010	0.006	0.003	0.003	0.010	0.006	0.003	0.003	0.013	1.010	1.006	1.003	1.003	1.013
45-49	0.008	0.006	0.004	0.002	0.001	0.006	0.004	0.002	0.001	0.001	1.006	1.004	1.002	1.001	1.001
50-54	-0.004	-0.003	-0.002	-0.001	-0.001	-0.003	-0.002	-0.001	-0.001	-0.000	0.997	0.998	0.999	-0.999	1.000
55-59	-0.046	-0.043	-0.037	-0.030	-0.023	-0.043	-0.037	-0.030	-0.023	-0.016	0.957	0.963	0.970	-0.977	-0.984
60-64	-0.077	-0.076	-0.073	-0.067	-0.059	-0.076	-0.073	-0.067	-0.050	-0.050	0.924	0.027	0.933	-0.941	-0.950
65 and over . .	-0.331	-0.333	-0.333	-0.332	-0.330	-0.333	-0.333	-0.332	-0.330	-0.327	0.667	0.667	0.668	-0.670	-0.673
<i>Females</i>															
15-19	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
20-24	0.416	0.405	—	—	—	0.404	0.403	—	—	—	1.404	1.403	—	—	—
25-29	-0.248	-0.249	-0.249	—	—	-0.248	-0.249	—	—	—	0.752	0.751	—	—	—
30-34	-0.016	-0.016	-0.016	-0.016	—	0.016	-0.016	-0.016	-0.016	—	0.984	0.984	0.984	—	—
35-39	0.108	0.107	0.105	0.107	0.106	0.107	0.106	0.106	0.106	0.106	1.107	1.106	1.106	1.106	1.106
40-44	0.088	0.086	0.086	0.084	0.086	0.087	0.085	0.085	0.085	0.085	1.087	1.085	1.085	1.085	1.085
45-49	0.022	0.023	0.024	0.025	0.025	0.022	0.023	0.024	0.025	0.025	1.022	1.023	1.024	1.025	1.025
50-54	-0.042	-0.042	-0.041	-0.041	-0.042	-0.042	-0.042	-0.041	-0.041	-0.041	0.958	0.958	0.959	0.959	0.959
55-59	-0.093	-0.092	-0.092	-0.091	-0.091	-0.093	-0.092	-0.092	-0.092	-0.091	0.907	0.908	0.908	0.909	0.909
60-64	-0.148	-0.148	-0.149	-0.151	-0.152	-0.148	-0.148	-0.150	-0.152	-0.153	0.852	0.852	0.850	0.849	0.847
65 and over . .	-0.453	-0.458	-0.454	-0.056	-0.463	-0.458	-0.455	-0.456	-0.464	-0.472	0.542	0.545	0.544	0.536	0.528

ANNEX VI (concluded)

Sex and age	Product of activity rates and inactivity rates						Correction coefficient				
(1)	1955 (29)	1960 (30)	1965 (31)	1970 (32)	1975 (33)	1980 (34)	1960/1955 (35)	1965/1960 (36)	1970/1965 (37)	1975/1970 (38)	1980/1975 (39)
<i>Males</i>											
15-19	2,495.59	2,499.51	—	—	—	—	1.00157	—	—	—	—
20-24	1,260.96	1,145.76	1,514.04	—	—	—	0.90864	1.32142	—	—	—
25-29	590.31	384.00	564.00	794.31	—	—	0.65050	1.46875	1.40835	—	—
30-34	465.99	281.59	186.39	438.84	519.75	—	0.60428	0.66191	2.35441	1.18437	—
35-39	402.36	272.16	138.04	108.79	384.00	337.71	0.67640	0.50720	0.78810	3.52973	0.87955
40-44	393.19	281.59	176.76	79.36	79.36	356.31	0.71617	0.62772	0.44897	1.00000	4.48979
45-49	429.75	319.11	224.71	138.04	59.64	69.51	0.74254	0.70417	0.61430	0.43204	1.16549
50-54	581.56	465.99	347.04	243.75	147.75	69.51	0.80127	0.74473	0.70236	0.60615	0.47045
55-59	1,002.31	939.75	819.00	668.16	510.84	365.56	0.93758	0.87150	0.81582	0.76454	0.71560
60-64	1,507.75	1,482.39	1,430.71	1,316.64	1,160.44	979.06	0.98318	0.96513	0.92027	0.88136	0.84364
65 and over	2,467.51	2,479.75	2,478.84	2,472.96	2,459.04	2,436.00	1.00496	0.99963	0.99762	0.99437	0.99063
<i>Females</i>											
15-19	2,497.11	2,498.79	—	—	—	—	1.00067	—	—	—	—
20-24	2,224.44	2,161.44	2,150.31	—	—	—	0.97168	0.99485	—	—	—
25-29	2,497.75	2,499.99	2,498.04	2,497.44	—	—	1.00090	0.99921	—	—	—
30-34	2,499.19	2,499.51	2,499.51	2,499.64	2,499.36	—	1.00013	1.00000	1.00005	0.99988	—
35-39	2,494.24	2,480.64	2,462.79	2,479.75	2,464.00	2,461.56	0.99455	0.99280	1.00688	0.99364	0.99900
40-44	2,471.91	2,451.00	2,417.19	2,381.19	2,417.19	2,383.36	0.99154	0.98620	0.98510	1.01511	0.98600
45-49	2,482.36	2,457.75	2,431.11	2,389.75	2,346.24	2,387.64	0.99009	0.98916	0.98298	0.98179	1.01764
50-54	2,499.75	2,496.39	2,483.19	2,465.19	2,436.00	2,403.96	0.99866	0.99471	0.99275	0.98815	0.98684
55-59	2,483.19	2,482.36	2,491.59	2,499.19	2,499.36	2,492.71	0.99967	1.00371	1.00305	1.00006	0.99733
60-64	2,381.19	2,381.19	2,379.00	2,401.99	2,431.11	2,452.39	1.00000	0.99908	1.00966	1.00834	1.00875
65 and over	1,664.79	1,682.04	1,670.56	1,676.31	1,704.76	1,738.24	1.01036	0.99317	1.00344	1.01697	1.01963

* Computations:

- (4) = (24) × preceding row (3)
 (5) = (25) × preceding row (4)
 (6) = (26) × preceding row (5)
 (7) = (27) × preceding row (6)
 (8) = (28) × preceding row (7)
 (9) = (3) × preceding row (2)
 (10) = (4) × preceding row (3)
 (11) = (5) × preceding row (4)
 (12) = (6) × preceding row (5)
 (13) = (7) × preceding row (6)
 (14) = (9) - 1
 (15) = (10) - 1
 (16) = (11) - 1
 (17) = (12) - 1
 (18) = (13) - 1
 (19) = (14) × (35)
 (20) = (15) × (36)

- (21) = (16) × (37)
 (22) = (17) × (38)
 (23) = (18) × (39)
 (24) = (19) + 1
 (25) = (20) + 1
 (26) = (21) + 1
 (27) = (22) + 1
 (28) = (23) + 1
 (29) = (2) × [100 - (2)]
 (30) = (3) × [100 - (3)]
 (31) = (4) × [100 - (4)]
 (32) = (5) × [100 - (5)]
 (33) = (6) × [100 - (6)]
 (34) = (7) × [100 - (7)]
 (35) = (30) : (29)
 (36) = (31) : (30)
 (37) = (32) : (31)
 (38) = (33) : (32)
 (39) = (34) : (33)

ANNEX VII

Japan: projection of the sex-age-specific activity rates of the population, 1965-1985: extrapolation by cohort

Sex and age	Activity rates							Cohort ratio ^a				
	Observed		Projected ^a									
	1955	1960	1965	1970	1975	1980	1985	1960/1955	1965/1960	1970/1965	1975/1970	1980/1975
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
<i>Males</i>												
15-19	52.1	50.7	—	—	—	—	—	—	—	—	—	—
20-24	85.2	86.8	84.5	—	—	—	—	1.666	1.666	—	—	—
25-29	93.7	96.0	97.8	95.2	—	—	—	1.127	1.127	1.127	—	—
30-34	95.1	97.1	99.5	101.3	98.6	—	—	1.036	1.036	1.036	1.036	—
35-39	95.8	97.2	99.2	101.7	103.5	100.8	—	1.022	1.022	1.022	1.022	1.022
40-44	95.9	97.1	98.5	100.5	103.0	104.8	102.1	1.014	1.013	1.013	1.013	1.013
45-49	95.5	96.7	97.9	99.3	101.3	103.8	105.6	1.008	1.008	1.008	1.008	1.008
50-54	93.8	95.1	96.3	97.5	98.9	100.9	103.4	0.996	0.996	0.996	0.996	0.996
55-59	88.7	89.5	90.7	91.9	93.0	94.4	96.3	0.954	0.954	0.954	0.954	0.954
60-64	81.5	81.9	82.6	83.7	84.8	85.8	87.1	0.923	0.923	0.923	0.923	0.923
65 and over	55.7	54.5	54.8	55.3	56.0	56.7	57.4	0.669	0.669	0.669	0.669	0.669
<i>Females</i>												
15-19	48.3	48.9	—	—	—	—	—	—	—	—	—	—
20-24	66.6	68.4	69.2	—	—	—	—	1.416	1.415	—	—	—
25-29	51.5	50.1	51.4	52.0	—	—	—	0.752	0.751	0.751	—	—
30-34	49.1	50.7	49.3	50.6	51.2	—	—	0.984	0.984	0.984	0.985	—
35-39	52.4	54.4	56.2	54.6	56.1	56.8	—	1.108	1.108	1.108	1.109	1.109
40-44	55.3	57.0	59.2	61.1	59.4	61.0	61.7	1.088	1.088	1.087	1.088	1.087
45-49	54.2	56.5	58.3	60.6	62.6	60.9	62.5	1.022	1.023	1.024	1.025	1.025
50-54	50.5	51.9	54.1	55.9	58.1	60.0	58.3	0.958	0.958	0.959	0.959	0.958
55-59	45.9	45.8	47.1	49.1	50.8	52.8	54.5	0.907	0.908	0.908	0.909	0.909
60-64	39.1	39.1	39.0	40.1	41.8	43.2	44.9	0.852	0.852	0.851	0.851	0.850
65 and over	21.1	21.4	21.4	21.3	21.9	22.8	23.5	0.547	0.546	0.546	0.546	0.545

^a Computations:

(9) = (3) : preceding age group (2)
 (10) = (4) : preceding age group (3)
 (11) = (5) : preceding age group (4)
 (12) = (6) : preceding age group (5)
 (13) = (7) : preceding age group (6)

(4) = (9) × preceding age group (3)
 (5) = (10) × preceding age group (4)
 (6) = (11) × preceding age group (5)
 (7) = (12) × preceding age group (6)
 (8) = (13) × preceding age group (7)

ANNEX VIII

Japan: projection of the sex-age-specific activity rates of the population, 1965-1985: method of ratios of contiguous age groups

Sex and age (1)	Activity rates				Ratios of contiguous age groups ^a				
	Observed		Projected ^a						
	1955 (2)	1960 (3)	1975 (4)	1985 (5)	1955 (6)	1960 (7)	1975 (8)	1975 (9)	1985 (10)
<i>Males</i>									
15-19	52.1	50.7	49.4	47.7	0.61150	0.58410	0.55793	0.55819	0.53343
20-24	85.2	86.8	88.5	89.4	0.90928	0.90416	0.89907	0.89939	0.89469
25-29	93.7	96.0	98.4	99.9	0.98527	0.98867	0.99208	0.99193	0.99519
30-34	95.1	97.1	99.2	100.4	0.99269	0.99897	1.00529	1.00506	1.01118
35-39	96.8	97.2	98.7	99.3	0.99895	1.00102	1.00309	1.00304	1.00506
40-44	95.9	97.1	98.4	98.8	—	—	—	—	—
45-49	95.5	96.7	98.0	98.4	0.99582	0.99588	0.99594	0.99593	0.99598
50-54	93.8	95.1	96.5	97.0	0.98219	0.98345	0.98471	0.98469	0.98593
55-59	88.7	89.5	90.4	90.4	0.94562	0.94111	0.93662	0.93678	0.93246
60-64	81.5	81.9	82.4	82.1	0.91882	0.91508	0.91135	0.91150	0.90793
65 and over	55.7	54.5	53.4	51.8	0.68343	0.66544	0.64792	0.64805	0.63111
<i>Females</i>									
15-19	48.3	48.9	51.6	52.8	0.72522	0.71491	0.70475	0.70491	0.69505
20-24	66.6	68.4	73.2	75.9	—	—	—	—	—
25-29	51.5	50.1	50.8	49.9	0.77327	0.73245	0.69378	0.69398	0.65753
30-34	49.1	50.7	54.6	57.0	0.95339	1.01197	1.07415	1.07580	1.14152
35-39	52.4	54.4	58.9	61.8	1.06720	1.07297	1.07877	1.07875	1.08455
40-44	55.3	57.0	61.3	63.9	1.05534	1.04779	1.04029	1.04074	1.03374
45-49	54.2	56.5	61.5	64.9	0.98010	0.99122	1.00247	1.00326	1.01543
50-54	50.5	51.9	55.7	58.0	0.93173	0.91858	0.90562	0.90569	0.89297
55-59	45.9	45.8	47.7	48.2	0.90891	0.88246	0.85678	0.85637	0.83105
60-64	39.1	39.1	40.8	41.3	0.85185	0.85371	0.85557	0.85534	0.85697
65 and over	21.1	21.4	22.6	23.2	0.53964	0.54731	0.55509	0.55392	0.56061

ANNEX VIII (continued)

Sex and age	Increase (decrease) in the ratios of contiguous age groups				Projected activity rates			Simple extrapolation			Increase (decrease)			
	1960/1955	1975/1960	1975/1960	1985/1975	1960	1975	1985	1965	1970	1980	1960/1975	5 years	1975/1985	5 years
(1)	(11)	(12)	(13)	(14)	(3)	(4)	(5)	(15)	(16)	(17)	(18)	(19)	(20)	(21)
Males														
15-19	0.955192	0.955192	0.95564	0.95564	50.7	49.4	47.7	50.3	49.8	48.6	-1.3	-0.43	-1.7	-0.85
20-24	0.994369	0.994369	0.99472	0.99472	86.8	88.5	89.4	87.4	87.9	89.0	1.7	0.57	0.9	0.45
25-29	1.003450	1.003450	1.00329	1.00329	96.0	98.4	99.9	96.8	97.6	99.2	2.4	0.80	1.5	0.75
30-34	1.006326	1.006326	1.00609	1.00609	97.1	99.2	100.4	97.8	98.5	99.8	2.1	0.70	1.2	0.60
35-39	1.002072	1.002072	1.00201	1.00201	97.2	98.7	99.3	97.7	98.2	99.0	1.5	0.50	0.6	0.30
40-44	—	—	—	—	97.1	98.4	98.8	97.5	98.0	98.6	1.3	0.43	0.4	0.20
45-49	1.000060	1.000060	1.00005	1.00005	96.7	98.0	98.4	97.1	97.6	98.2	1.3	0.43	0.4	0.20
50-54	1.001282	1.001282	1.00126	1.00126	95.1	96.5	97.0	95.6	96.0	96.8	1.4	0.47	0.5	0.25
55-59	0.995230	0.995230	0.99539	0.99539	89.5	90.4	90.4	89.8	90.1	90.4	0.9	0.30	0.0	0.00
60-64	0.995929	0.995929	0.99608	0.99608	81.9	82.4	82.1	82.1	82.2	82.3	0.5	0.17	-0.3	-0.15
65 and over	0.973676	0.973676	0.97386	0.97386	54.5	53.4	51.8	54.1	53.8	52.6	-1.1	-0.37	-1.6	-0.80
Females														
15-19	0.985783	0.985783	0.98601	0.98601	48.9	51.6	52.8	49.8	50.7	52.2	2.7	0.9	1.2	0.6
20-24	—	—	—	—	68.4	73.2	75.9	70.0	71.6	74.6	4.8	1.6	2.7	1.35
25-29	0.947211	0.947211	0.94747	0.94747	50.1	50.8	49.9	50.3	50.6	50.4	0.7	0.23	-0.9	-0.45
30-34	1.061443	1.061443	1.06208	1.06208	50.7	54.6	57.0	52.0	53.3	55.8	3.9	1.3	2.4	1.2
35-39	1.005406	1.005406	1.00538	1.00538	54.4	58.9	61.8	55.9	57.4	60.4	4.5	1.5	2.9	1.45
40-44	0.992845	0.992845	0.99327	0.99327	57.0	61.3	63.9	58.4	59.9	62.6	4.3	1.43	2.6	1.3
45-49	1.011345	1.011345	1.01214	1.01214	56.5	61.5	64.9	58.2	59.8	63.2	5.0	1.67	3.4	1.7
50-54	0.985886	0.985886	0.98596	0.98596	51.9	55.7	58.0	53.2	54.4	56.9	3.8	1.27	2.3	1.15
55-59	0.970899	0.970899	0.97043	0.97043	45.8	47.7	48.2	46.4	47.1	48.0	1.9	0.63	0.5	0.25
60-64	1.002183	1.002183	1.00190	1.00190	39.1	40.8	41.3	39.7	40.2	41.1	1.7	0.57	0.5	0.25
65 and over	1.014213	1.014213	1.01207	1.01207	21.4	22.6	23.2	21.8	22.2	22.9	1.2	0.4	0.6	0.3

* Computations:

The central age group is assumed to be 40-44 for males and 20-24 for females.

- (4) = (4) 40-44 × (8) 35-39 = (4) 35-39 etc.
 (5) = (5) 40-44 × (10) 35-39 = (5) 35-39 etc.
 (6) = (2) 35-39 : (2) 40-44; etc.
 (7) = (3) 35-39 : (3) 40-44; etc.
 (8) = (12) × (7); computed for the assumption in (12)
 (9) = (4) 35-39 : (4) 40-44; computed from the figures projected in (4)
 (10) = (14) × (9)
 (11) = (7) + (6)

- (12) = assumed to be the same as (11)
 (13) = (9) + (7)
 (14) = assumed to be the same as (13)
 (15) = (3) + (19)
 (16) = (15) + (19)
 (17) = (4) + (21)
 (18) = (4) - (3)
 (19) = (18) : 3
 (20) = (5) - (4)
 (21) = (20) : 2

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