

Chapter I

MEASURES OF THE DEMOGRAPHIC DIMENSIONS OF THE LABOUR FORCE

A. Measures of the absolute and relative size of the labour force

The labour force statistics provided by a population census can be viewed as an inventory of a nation's supply of labour engaged in or available for income-producing activities. As a measure of labour supply, however, the number of persons in the labour force is only a first approximation since it does not take into account how much work members of the labour force are willing and able to do. The quantity of labour supply corresponding to a given number of workers may vary widely, depending to a large extent on the customary weekly hours of work and the numbers of workers available only for part-time, seasonal, or irregular employment, and also on such factors as the frequency of holidays, the worker's state of health and incidence of disabilities. On account of the trend towards a shorter working week which has for a century been observed generally in countries undergoing industrialization, measures of labour force growth derived from the censuses of such countries are likely to exaggerate long-term increases of the labour supply. Numbers of persons in the labour force can be converted into estimates of labour supply in terms of man-hours per week, year or other period, if sufficient information is available on the number of hours worked and the willingness and ability of individuals to work more. ^{1/} Such measures are still only approximate, though, since inexactness is inherent in the information relating to economic activities obtained in population censuses.

Another point which should not be forgotten in interpreting the statistics is that the supply of labour may be influenced by the demand, that is, by the volume of employment opportunities, including opportunities for self-employment and unpaid family work as well as paid employment. In general, demand conditions are likely to be more influential in shaping the distribution of the labour force among industries, occupations, and areas within a country than in determining its total size, but their influence in the latter connexion is not to be neglected.

In proportion to the size of the population, the size of the labour force is measured by the crude activity rate, that is, the percentage of the total population classified in the census as economically active. For example, in the 1961 census of Indonesia, 34,578,234 persons were classified in the labour force out of the total population of 96,318,829; thus the crude activity rate was 35.9 per cent. ^{2/} Crude activity rates may also be calculated with reference to

^{1/} For example, see James N. Morgan, Ismael A. Siragelden and Nancy Baerwaldt, Productive Americans (Ann Arbor, Survey Research Center, Institute for Social Research, University of Michigan, 1966), Monograph 43; also Clarence D. Long, The Labor Force under Changing Income and Employment (Princeton, 1958), Appendix E.

^{2/} Unless otherwise noted, statistics quoted in this manual are taken from the national statistical publications or the United Nations, Demographic Yearbook, 1956, 1964, and 1965 (Sales Nos.: 56.XIII.5, 65.XIII.1 and 66.XIII.2).

the male and female population separately, showing to what extent the two sexes contribute to the body of income-producing workers, as illustrated below with the data of the 1961 Indonesian census:

	<u>Male</u>	<u>Female</u>
Population	47 493 854	48 824 975
Labour Force	25 008 797	9 569 437
Crude activity rate	52.7	19.6

The crude activity rate has an obvious economic significance: the higher this rate (if it is measured accurately according to a given definition of the labour force), the higher is the level of income per head that can be achieved under given conditions of productivity and extent of employment of the labour force. But income is not everything; there are many workers not included in the concept of the labour force because what they produce is not considered as income, although it contributes materially to the well-being of the population. In most countries, the great majority of adults not classified in the labour force are housewives; they produce domestic services and goods for home consumption, the value of which may amount, in the aggregate, to quite a sizeable fraction of the total value of goods and services of all kinds produced by the nation, although the housewives' products are not included in the conventional accounting of national income. ^{3/} So the apparent advantage of a high crude activity rate is partly illusory if it is achieved by many women being engaged in paid employment instead of unpaid work in the home.

In most censuses, questions relating to economic activities are limited to persons above some specified minimal age, usually in the range of ten to fifteen years. In some cases, the age limitation may exclude a considerable number of children engaged to some extent in economic activities, and although their contributions to production may be relatively minor as a rule, the analyst should take account of the understatement of the size of the labour force if the minimal age appears to have been placed too high. It is useful to calculate refined activity rates by relating the labour force totals to the population above the specified minimal age, in addition to the crude activity rates related to the population of all ages. For example, with the data of the 1961 Indonesian census, where the minimal age for the labour force enumeration was set at ten years, the calculation is made as follows:

	<u>Both Sexes</u>	<u>Males</u>	<u>Females</u>
Population, 10 years and over . .	63 953 563	31 348 371	32 605 192
Labour force, 10 years and over .	34 578 234	25 008 797	9 569 437
Refined activity rate	54.1	79.8	29.3

^{3/} On the hours worked by housewives and the value of their products, see Colin Clark "The economics of house-work", Bulletin of the Institute of Economics and Statistics of Oxford University (Oxford) May 1958, No. 2; Alain Girard, "Le budget-temps de la femme mariée dans les agglomérations urbaines", Population (Paris), vol. 13, 1958 and "Le budget-temps de la femme mariée à la campagne", Population (Paris), vol. 14, 1959; Morgan, Siragelden and Baerwaldt, op. cit.

Unlike crude activity rates, the refined rates are true rates, that is to say, measures of participation in economic activities in the population "at risk". ^{4/} They are free, from the distortion produced by the presence, in varying proportions in the population, of children too young to be classified as economically active. Variations of the refined rates may differ appreciably from those of crude activity rates where the age structures of the populations involved in comparisons differ (as a result of age-selective migratory movements, variations of birth rates and the like). An example is provided by the following comparison of activity rates for urban and rural areas of Indonesia derived from the data of the 1961 census:

	<u>Activity rates, both sexes</u>	
	Crude rates (as a percentage of total population)	Refined rates (as a percentage of population aged 10 years and over)
Total Indonesia	35.9	54.1
Urban areas	32.7	47.1
Rural areas	36.5	55.4
Ratio of urban to rural rate (rural = 100) . .	90	85

The analyst must beware of the spurious variations in the measures of labour force dimensions which result from differing definitions or differing interpretations and applications of the same definitions in census operations. Caution is required above all in comparing the statistics of different countries, but it is needed also in comparing data from successive censuses of the same country and data for different areas and population groups within a country. For example, in the following comparison of crude activity rates for regions of Indonesia (1961 census), the figures for both sexes imply an appreciable relative advantage in size of the labour force for Kalimantan and Djogjakarta and a relative disadvantage for Sulawesi and West Java. However, the observation that the variations are mainly in the female rates signals the need for investigating the consistency of application of the census concepts in the different regions before the apparent differences are accepted as representative of reality.

^{4/} In some censuses, certain segments of the population above the specified minimal age are excluded by definition from the labour force enumeration (inmates of institutions and military personnel, for example). If such excluded groups are numerically very small, their inclusion in the base population figures on which the activity rates are calculated is of little consequence. On the other hand, where they constitute a sizeable proportion of the population (as they may in some localities or categories of the population if not in the national total) it may be advisable to subtract them from the population base figures before computing refined rates, age-specific rates and others.

Crude activity rates

	<u>Both sexes</u>	<u>Males</u>	<u>Females</u>
Djakarta	34.0	52.9	14.4
West Java.	32.7	51.2	14.8
Central Java	35.0	51.8	19.1
Djogjakarta.	41.0	50.1	32.4
East Java.	39.4	56.5	23.3
Sumatra.	36.0	50.3	21.5
Kalimantan	41.7	54.9	28.3
Sulawesi	30.7	50.1	11.8
Other islands. . . .	35.9	54.1	17.8
Total, Indonesia	35.9	52.7	19.6

Some pitfalls in the measurement of differences between activity rates of different countries and changes in the rates for the same country over a period of time can be illustrated with reference to the following data from censuses of Peru and Turkey:

Crude activity rates

	<u>Both sexes</u>	<u>Males</u>	<u>Females</u>
Peru: 1940.	39.9	52.1	27.9
1961.	31.5	49.6	13.6
Turkey: 1955.	50.7	56.8	44.5
1960.	46.8	54.3	39.0

These figures make Turkey's situation appear much more favourable than Peru's as regards the numerical relationship between labour supply and population, but the difference is probably to a great extent a reflection of different practices in reporting the economic activities of women in the censuses of the two countries. In the Turkish censuses, the practice has been to classify almost all women in farm households as economically active (in the category of unpaid helpers on the farm if not self-employed or wage-workers), whereas relatively few women in the farm population have been so classified in the censuses of Peru. To be sure, it is possible that Turkish women do take a greater part in farm work than Peruvian women do; but the difference, if any, is almost certainly exaggerated by the census statistics.

For Peru, the statistics indicate a pronounced decrease in the crude activity rate between the censuses of 1940 and 1961, but the amount of the actual decrease, if any, is almost certainly exaggerated as a result of a change of definitions. At the 1940 census, the labour force was defined in terms of a "usual occupation" concept, whereas a definition referring to activities during a specified week was adopted for the 1961 census. The observation that the apparent reduction of the activity rate is much greater on the female than on the male side accords with the generalization that varying definitions, as well as reporting errors and biases, are likely to have more effect on measures of the female than of the male labour force.

Difficulties of comparison of recent census data referring to activities during a specified period of time and earlier data referring to usual activities are encountered very often in studies of historical series of census data. It is of course desirable if possible in such cases to make adjustments in order to put the series on a more nearly comparable basis, but such adjustments require information which may not be easy to obtain.

Shifting from a usual activity question to one on activity during a relatively brief period is likely to reduce the numbers of persons in certain categories reported as economically active: those, for example, who normally work during the greater part of the year but are inactive in the season in question, and possibly persons who have recently retired or become disabled. On the other hand, the shift may have the opposite effect in some other categories: for instance, persons who work during the season in question but not normally at other times of the year, those who work occasionally or irregularly and who happen to have been employed or seeking work during the period in question, new entrants into the labour force seeking their first jobs, and possibly housewives and students who normally work only part-time in economic activities. In order to estimate the net effect of a shift in the basis of the questions, one needs at least to have some information about the relative numbers of persons in these various categories; and such information is not sufficient for a thoroughly reliable estimate unless there is also some basis for gauging the effect within each category. The kind of information needed might be obtained by conducting sampling surveys in such a manner as to estimate the numbers of persons in various categories who would be classified as economically active under each concept.

The form of the questions has to be considered as well as the time reference. In the earlier censuses of many countries, where the enquiry referred to usual activities, there was often no specific question as to whether each individual was usually economically active or not. Rather, there was a question on the usual occupation (with or without separate questions referring to industry and status), and labour force totals were obtained by counting persons who reported an economic activity as the usual occupation. Thus persons who failed to report any occupation would be omitted from the labour force count although they might have been usually economically active. In recent censuses where a specific time reference has been adopted, a common practice has been to introduce a separate question (or questions) for determining whether or not each individual was economically active (employed or unemployed) during the specified period, in addition to questions on occupation, industry, and status; thus economically active persons whose occupation (industry, status) is not reported are not on that account omitted from the enumeration of the labour force. This difference in the form of the questions is a factor making for a larger measure of the labour force in the more recent censuses, and some indication of its possible

effect is given by the numbers of persons reported as economically active with occupation (industry, status) not reported. 5/

Because the statistics for females are likely to be much more affected than those for males by variations of definition, errors, and biases, sometimes only the statistics for males are considered in international and historical comparisons. While this solution may be justified in some circumstances, there is a risk of serious misrepresentation of real variations in the dimensions of the labour force. In many cases, variations of the female component are more important than those of the male component, and variations on the female side cannot be expected to parallel those on the male side. For example, in the comparison of statistics for regions of Indonesia shown above, if attention is confined to the figures for males, Djogjakarta appears as a region with one of the smallest labour forces in proportion to its population, yet it ranks near the top of the list for its crude activity rate when the admittedly dubious statistics for females are also taken into account. A similar objection also applies to the subtraction of the statistics for unpaid family workers from labour force totals, a technique which is also sometimes used in order to minimize the effects of variations of definition, reporting errors and biases. 6/

B. Dependency ratios

Persons not in the labour force may be regarded from a social point of view as dependants in the sense that they consume but do not produce income, although they may be independent financially (receiving personal incomes in the form of pensions, rents, dividends and so on) and, as already mentioned, they may produce goods and services not considered as income. A crude measure of the burden of those who produce no income upon the shoulders of income-producers is given by the dependency ratio, defined as the number of persons not in the labour force per 100 of the labour force. This merely restates in different form the same relationship expressed by the crude activity rate. For example, from the 1961 Indonesian census totals of 61,740,595 persons not in the labour force and 34,578,234 in the labour force, one obtains a dependency ratio of 178.6 per 100. The ratio is higher in the urban areas (205.5) than in the rural areas of Indonesia (174.3).

5/ For an example of an attempt to estimate the effect of a change from questions on usual occupation, industry, and status, to questions on activities during a specified week, see United States Bureau of the Census, "Estimates of Labor Force, Employment and Unemployment in the United States, 1940 and 1930" Sixteenth Census of the United States, 1940, Population (Washington). For additional examples of the treatment of various problems of comparison in historical series of labour force statistics, see G.F. Cumper, "A comparison of statistical data on the Jamaican labour force 1953-61", Social and Economic Studies (Jamaica), December 1964; Avner Hovne, The Labour Force in Israel (Jerusalem, 1961); B.R. Kalra, "A note on working force estimates, 1901-61", Census of India (1961), Paper No. 1 of 1962. Final Population Totals (New Delhi, 1962), Appendix I.

6/ For example, see Demographic Aspects of Manpower. Sex and Age Patterns of Participation in Economic Activities (United Nations publication, Sales No.: 61.XIII.4).

Of course, the weight of the dependency load is not only a matter of the number of dependants but also of their sex-age distribution and, even more important, of standards for their maintenance, education for the children, housing and health services for the elderly. Dependency ratios may give a badly biased measure of relative loads especially in comparisons between urban and rural communities and between areas which differ greatly in levels of social and economic development. Given data on average values of consumption according to age and sex, including outlays for education and other socially provided services, the analyst would be in a position to calculate refined measures of dependency with varying weights for different categories of the economically inactive population in different areas. Such data are not widely available, though, and many complications arise in their use for this purpose. Without adequate data, it is doubtful whether it is advisable to attempt refinements by applying arbitrary weights, by assuming, for example, that the needs of an adult dependant in the central age groups are represented by a weight of unity, those of a pre-school child by, say, one-fourth, and so on for other categories.

Because of the uncertainties in census data on the economic activities of females and because the dependency of housewives not in the labour force is not comparable to that of economically inactive men, studies of the variations of dependency ratios are sometimes confined to the statistics for the male population. The findings are then subject to the kinds of reservations noted in the preceding section as regards the use of activity rates of males alone to measure differences in relative size of the labour force in various populations. Another common practice is to calculate dependency ratios from statistics of population age-groups without regard to actual participation in economic activities - for example, considering all persons between the ages of fifteen and sixty or sixty-five as producers and all those in younger and older age groups as dependants. ^{7/} Needless to say, there is some lack of realism in measures calculated on this basis.

C. Sex-Age specific activity rates

Economic activity is, of course, not distributed at random within either the male or the female population of potentially employable age. The proportion of economically active persons differs in different categories of the population, ranging from near 100 per cent in some categories down to zero in others. These variations are measured by specific activity rates or "labour force participation rates", as they are sometimes called. A specific activity rate is calculated by the formula:

$$r = \frac{P_e}{P_t} \times 100$$

where P_e is the number of economically active persons in the specified category of the population and P_t is the total number of persons in the same category.

^{7/} Among many examples, see F.W. Notestein, Irene B. Taeuber, Dudley Kirk, A.J. Coale and L.K. Kiser, The Future Population of Europe and the Soviet Union (Geneva, League of Nations, 1944).

Specific activity rates may be calculated for population categories defined in terms of various characteristics, including sex, age, marital status, educational level, urban-rural residence, ethnic groupings and others if the relevant classifications of population and the labour force are provided in the census tabulations. The uses of various kinds of specific rates for studying demographic, economic and social factors which affect the size, growth and composition of the labour force will be considered in the next chapter. The discussion here is confined to activity rates specific for sex and age, which are fundamental in the measurement of labour force dimensions.

An example of the calculation of sex-age specific activity rates, using the statistics of the 1960 census of Panama (without the Canal Zone), is given in table 1. The Panamanian rates are charted in figure I and some examples of sex-age specific rates for other countries are shown in table 2. ^{8/}

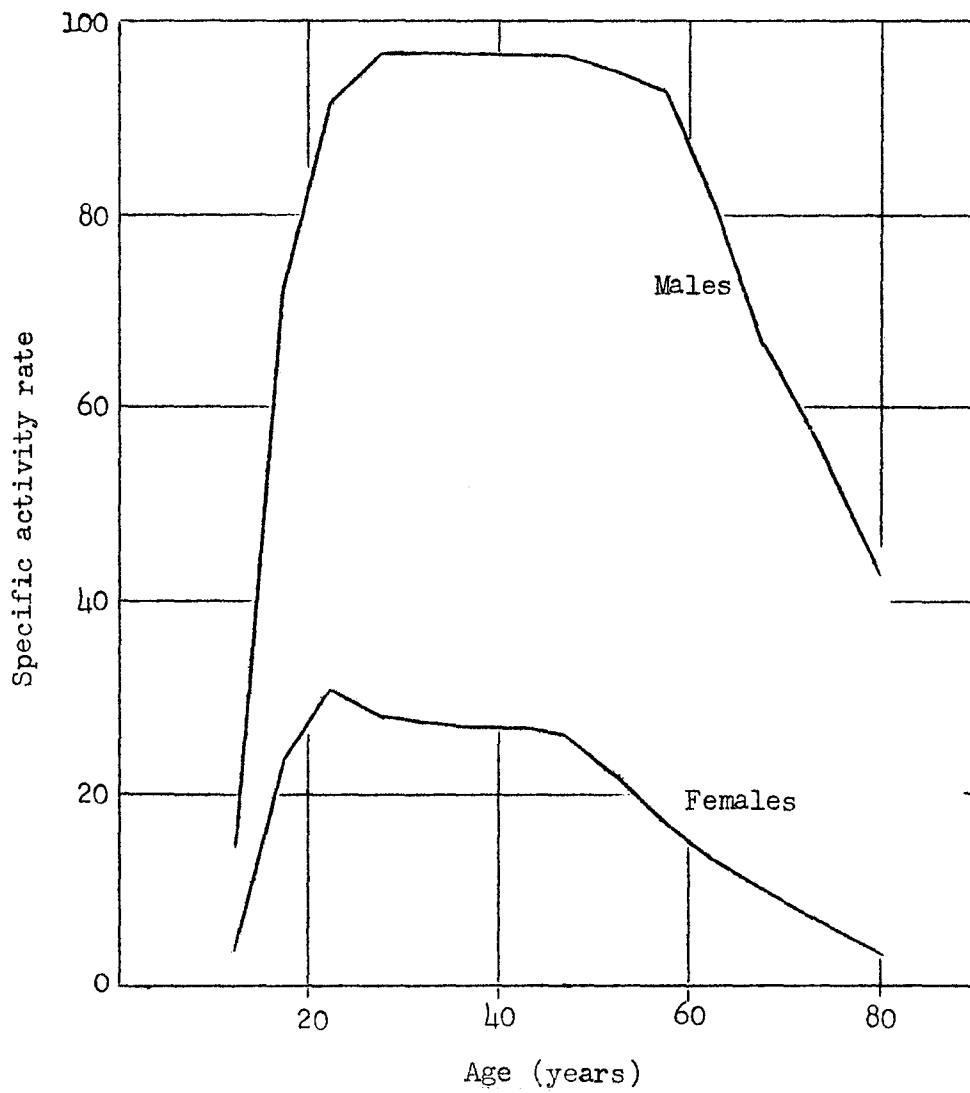
Table 1
Panama, 1960: population, labor force and specific activity rates by sex and age

Age (years)	Males			Females		
	Population	Labour force	Activity rate	Population	Labour force	Activity rate
Total,						
10 and over	356 487	265 020	74.3	342 137	71 949	21.0
10-14	62 485	8 953	14.3	60 414	2 312	3.8
15-19	50 506	31 928	63.2	51 127	12 003	23.5
20-24	42 770	39 476	92.3	42 242	13 191	31.2
25-29	35 605	34 357	96.5	34 839	9 874	28.3
30-34	31 688	30 753	97.0	30 156	8 364	27.7
35-39	28 573	27 747	97.1	26 995	7 312	27.1
40-44	25 415	24 678	97.1	22 789	6 151	27.0
45-49	22 013	21 219	96.4	19 685	5 146	26.1
50-54	16 338	15 517	95.0	14 328	3 118	21.8
55-59	12 010	11 102	92.4	11 578	2 019	17.4
60-64	10 541	8 626	81.8	9 789	1 260	12.9
65-69	6 955	4 792	68.9	6 562	633	9.6
70-74	5 678	3 283	57.8	5 072	338	6.7
75 and over	5 910	2 589	43.8	6 561	228	3.5

^{8/} A broad international compilation of such measures is found in the United Nations Demographic Yearbook, 1956, 1964 and 1965, chap. II, note 2; the patterns of variation are analysed in Demographic Aspects of Manpower, Sex and Age Patterns of Participation in Economic Activities (United Nations publication, Sales No.: 61.XIII.4).

Figure I

Age-specific activity rates of males and females,
Panama, 1960



Source: Table 1.

Table 2

Specific activity rates by sex and age, selected countries

Age (years)	<u>Ghana,</u> 1960		<u>Colombia,</u> 1951		<u>Indonesia,</u> 1961		<u>Iran,</u> 1956		<u>Thailand,</u> 1960		<u>Turkey,</u> 1960	
	Males	Females	Males	Females	Males	Females	Males	Females	Males	Females	Males	Females
10 and over	...	...	79.7	17.7	79.8	29.3	83.9	9.2	82.7 ^{a/}	77.2 ^{a/}	...	...
15 and over	89.1	56.6	93.3	20.0	88.9	31.2	93.4	9.4	89.5	81.4	93.6	65.3
10-14	...	...	16.9	6.2	22.6	15.6	29.7	8.2	40.5 ^{b/}	50.6 ^{b/}	...	...
15-19	61.5	53.7	84.8	23.6	66.7	30.6	80.7	12.1	76.9	84.7	78.9	66.2
20-24	91.0	52.3	95.4	23.9	87.2	27.4	94.2	9.3	88.2	86.6	94.3	65.8
25-29	96.5	51.5	97.3	20.2	94.4	27.2	98.3	8.6	96.0	85.0	97.4	66.6
30-34	97.5	57.0	97.9	19.0	96.8	33.3	98.9	9.7	97.5	85.2	98.2	65.2
35-39	97.5	59.3	98.0	19.2	95.6	39.8	97.8	10.1	97.8	86.6	98.4	63.3
40-44	97.3	65.4	97.7	19.1	94.8	15.9	93.7	8.7	97.6	87.6	98.3	64.5
45-49	96.9	67.0	97.3	18.2	93.7	27.8	74.1	5.8	94.5	80.9	96.8	62.5
50-54	96.0	69.6	96.4	17.7	89.6	39.1	93.7	8.7	94.5	80.9	96.8	62.5
55-59	93.7	70.6	94.8	15.9	89.6	39.1	93.7	8.7	94.5	80.9	96.8	62.5
60-64	89.1	64.0	90.5	15.5	89.6	39.1	93.7	8.7	94.5	80.9	96.8	62.5
65 and over	71.5	43.2	71.8	10.3	72.7	27.8	74.1	5.8	64.4	40.0	85.6	60.0
Unknown	...	...	...	...	82.2	53.2	61.9	11.1	72.0	64.2	50.1	28.5

a/ 11 years and over.

b/ 11-14 years.

The age-curve of specific activity rates of Panamanian males takes the form which is found almost universally in the statistics of countries throughout the world. Males come into the labour force at various ages, mostly before twenty and some between twenty and twenty-four years; nearly all are economically active by the age of twenty-five and remain so until about fifty-five, after which age there is a progressive attrition of the male labour force by voluntary or enforced retirement. Variations of this pattern in the statistics of different populations relate primarily to the age distribution of labour force entries below twenty-five years and of retirements above fifty-five years. It is useful to define these features as clearly as possible by computing specific activity rates in the finest age groupings which the census provides at the two extremes of the range of working ages - preferably by single years of age below twenty and five-year groups from fifty-five up to the age at which the number of men remaining in the labour force drops to a negligible figure.

For females, the age-curves of specific activity rates take more diverse forms, as illustrated by the foregoing tables and figure, and the female rates cannot be interpreted so simply in terms of ages of entry into and retirement from the labour force. The female activity rates for Panama, for example, rise to a maximum in the age group of twenty to twenty-four years and decline thereafter; but some women may enter the labour force for the first time in their thirties, forties, or even later, while others are retiring, and some women may move into and out of the labour force several times in the course of their lives. Thus the proportion of women who are economically active at some time during their lives may be much greater than the activity rate for any one age group.

Sex-age specific activity rates may sometimes be as interesting to the analyst for the questions which they raise as for the information which they give. For example, in studying the data for Thailand (table 2), the analyst would be struck by the observation that the female activity rates are far higher than those shown by the censuses of most other countries, and the explanation of this should be one of the first questions to which he would direct his investigation. Are Thai women really economically so much more active than the women of other countries, or was the reporting of their economic activities in the Thai census more liberal, and is it possible that many of those classified in the labour force were not really engaged in economic activities to any significant extent? Do the census returns show female activity rates at this high level prevailing throughout the country or only in certain areas? (Actually, lower female rates were recorded in urban than in rural areas.) On the other hand, the analyst working with the statistics of Iran would be led to enquire into the reasons for the very low female activity rates and the possibility of many economically active women not having been reported as such.

Referring again to the Thai statistics, the analyst would observe that higher activity rates are recorded for females than for males in the age groups under twenty, while the male rates are higher in the age groups from twenty years upward. The explanation of this anomaly, too, should be one of the objects of analysis, and in this connexion the analyst would wish to look into available information on school enrolments of males and females according to age groups or levels of education (see chapter II).

In a study of the statistics of Ghana or Indonesia, one of the questions which would come to the fore is the explanation of the pattern of rising female activity rates with increasing age over the range from the twenty-five to

twenty-nine year group to the forty-five to fifty-four year group in Indonesia and fifty-five to fifty-nine in Ghana. In this connexion, it would be pertinent to investigate the relationships of marital status, maternal status, age and economic activity of women in these countries (see chapter II). The Turkish data furnish a remarkable example of the effects of misreporting of ages in the census upon activity rates which accounts for the patently erratic see-saw pattern exhibited by the rates for Turkish women in successive age groups. This is probably the result of the "heaping" of age reports on multiples of ten years that occurs to a greater extent in rural communities (where female activity rates in Turkey are very high) than in the cities. 8/

D. Tables of economically active life

The sex-age specific activity rates derived from a census together with a life-table representing contemporary conditions of mortality in the population are the materials for calculating tables of economically active life (also called "tables of working life", "labour force life-tables" and so forth). Such tables represent the life-cycle of economic activity in hypothetical cohorts, that is, generations of males or females subject at each period of their lives to given rates of mortality and of participation in economic activities. The tables provide measures of the average length of economically active life, and age-specific rates of entry into and retirement from the labour force and depletion of the labour force by death. They are useful in studying the processes of growth and structural change of the labour force, estimating such quantities as life-time expectations of earnings, evaluating returns from investments in human capital, assessing economic implications of changes in activity rates and age-structure of the population etc.

Table 3 is an example of an abridged table of economically active life referring to the male population of Malaya as of the 1957 census. This table has been constructed from data compiled and analysed by Saw Swee-Hock. 9/ The methods of deriving the various functions are explained below. An abridged table of this kind gives measures for age intervals of five years. Complete tables of

8a/ This inference is substantiated by the fact that erratic fluctuations in the activity rates for women in Turkey largely disappear when such rates are calculated separately for urban and rural areas.

9/ Swee-Hock Saw, "Malaya: Tables of male working life, 1957", Journal of the Royal Statistical Society (London), series A, vol. 128, No. 3, 1965.

Table 3

Abridged table of economically active life, male population of Malaya, 1957

Age interval (exact ages, x to x+5)	Specific activity rates		Survivors at age x of 10,000 born alive		Stationary population in age interval		Cumulated stationary population in ages x - ∞		Expectation of life at age x		
	In age interval	At beginning age (x)	Total (l_x)	Economi- cally active (4x3)	Total (${}_5L_x$)	Economically active (6x2)	Total (T_x)	Economically active	Total years (e_x) (8:4)	Economi- cally active years (9:4)	Inactive years (10-11)
1	2	3	4	5	6	7	8	9	10	11	12
0-5	0	0	10 000	0	45 135	0	557 484	372 924	55.7	37.3	18.4
5-10	0	0	8 817	0	43 788	0	512 349	372 924	58.1	42.3	15.8
10-15	9.66	0	8 698	0	43 265	4 179	468 561	372 924	53.9	42.9	11.0
15-20	59.99	34.8	8 608	2 996	42 815	25 685	425 296	368 745	49.4	42.8	6.6
20-25	92.70	76.3	8 518	6 499	42 295	39 207	382 481	343 060	44.9	40.3	4.6
25-30	97.49	95.1	8 400	7 988	41 655	40 609	340 186	303 853	40.5	36.2	4.3
30-35	97.82	97.7	8 262	8 072	40 878	39 987	298 531	263 244	36.1	31.9	4.2
35-40	97.70	97.8	8 089	7 911	39 872	38 955	257 653	223 257	31.8	27.6	4.2
40-45	97.17	97.4	7 860	7 656	38 535	37 444	217 781	184 302	27.7	23.4	4.3
45-50	96.19	96.7	7 554	7 305	36 718	35 319	179 246	146 858	23.7	19.4	4.3
50-55	93.70	94.9	7 133	6 769	34 240	32 083	142 528	111 539	20.0	15.6	4.4
55-60	88.43	91.1	6 563	5 979	30 908	27 332	108 288	79 456	16.5	12.1	4.4
60-65	81.30	84.9	5 800	4 924	26 568	21 600	77 380	52 124	13.3	9.0	4.3
65-70	70.15	75.7	4 827	3 654	21 202	14 873	50 812	30 524	10.5	6.3	4.2
70-75	57.66	63.9	3 654	2 335	15 058	8 682	29 610	15 651	8.1	4.3	3.8
75-∞	47.89	52.8	2 369	1 251	14 552	6 969	14 552	6 969	6.1	2.9	3.2

Source: Columns 2, 4, 6, 8, 10 from Swee-Hock Saw, *op. cit.* Other columns computed as explained in text.

Table 3 (continued)

Age interval (exact ages, x to x+5)	Average active years per active survivor of age x	Components of annual change in number of economically active persons during age interval							
		Net increase (+) or decrease (-)	Deaths of active persons		Net entries into economic activity		Net retirements into inactive status		
			Number	Rate per 1,000 active (15:7)	Number	Rate per 1,000 inactive	Number	Rate per 1,000 active (19:7)	
1	13	14	15	16	17	18	19	20	
0-5	-	-	-	-	-	-	-	-	-
5-10	-	-	-	-	-	-	-	-	-
10-15	50.5	+2 996	9	2.2	3 005	76.9	-	-	-
15-20	46.0	+3 503	54	2.1	3 557	207.6	-	-	-
20-25	41.5	+1 489	110	2.8	1 599	517.8	-	-	-
25-30	37.0	+ 84	134	3.3	218	208.4	-	-	-
30-35	32.6	- 161	169	4.2	8	9.0	-	-	-
35-40	28.2	- 255	223	5.7	-	-	32	0.8	-
40-45	24.1	- 351	297	7.9	-	-	54	1.4	-
45-50	20.1	- 536	404	11.4	-	-	132	3.7	-
50-55	16.5	- 790	531	16.6	-	-	259	8.1	-
55-60	13.3	-1 055	673	24.6	-	-	382	14.0	-
60-65	10.6	-1 270	785	36.3	-	-	485	22.5	-
65-70	8.4	-1 319	821	55.2	-	-	498	33.5	-
70-75	6.7	-1 084	747	86.0	-	-	337	38.8	-
75-∞	5.6	-1 251	531	76.2	-	-	720	103.3	-

economically active life give the measures for each single year of age; an example is shown in the annex. 10/

The calculation begins with the age-specific activity rates (column 2) derived by Saw from the 1957 Malayan census. 11/ In addition to the rates for five-year age intervals, specific rates for the beginning age of each interval (column 3) are required in the calculation of some of the measures. In the present table, following Saw's procedure, these have been obtained by a simple interpolation formula, averaging the rates for successive pairs of five-year

10/ For other examples of tables of economically active life, see J.L. Sadie, Población y Mano de Obra en Chile, 1930-1975. (Santiago de Chile, United Nations, Centro Latino-Americano de Demografía, 1964, E/CN.CELADE/A.5); Augustin García and Nivia E. Castro V., Republica de Panama, volumen II. Proyección de la Población Económicamente Activa 1950-1975, y Tabla de Vida Activa Masculina para la República y el Distrito de Panamá, 1950 (Santiago de Chile, United Nations, Centro Latino-Americano de Demografía 1965 (E/CN.CELADE/C.24); Koya Azumi, "Length of working life of Japanese men, 1930 and 1955", Monthly Labor Review (Washington, D.C., United States Bureau of Labor Statistics), December 1958; S. Kono, Abridged Manpower Life Table for Males, 1960 (Tokyo, Institute of Population Problems, 1965), Research Report No. 1965 (In Japanese); New Zealand Census and Statistics Department, Table of Working Life, 1951: Male Population (including Maoris) (Wellington, 1955); Emil Pallós and Emil Valkovics, "A Gazdaságilag aktív és inaktív élettartam" (Length of economically active and inactive life) Demográfia (Budapest), vol. VIII, No. 1, 1965; P. Depoid, "Tables françaises concernant la population masculine (1906-1946)", Bulletin of the International Statistical Institute (The Hague) 1951, part IV; United Kingdom of Great Britain, Ministry of Labour. The Length of Working Life of Males in Great Britain (London, 1959); United States Bureau of Labor Statistics, Stuart Garfinkle, Tables of Working Life for Women, 1950 (Washington, 1957), Bulletin 1204; United States, Office of Manpower, Automation and Training, Stuart Garfinkle, The Length of Working Life for Males 1900-1960 (Washington, 1963); United States Department of Labor, Stuart Garfinkle, Work-Life Expectancy and Training Needs of Women (Washington, 1967), Manpower Report No. 12; United States Bureau of Labor Statistics, Tables of Working Life - Length of Working Life for Men (Washington, 1950), Bulletin No. 1001. Expectation of economically active life of males at birth is given for many countries in Demographic Aspects of Manpower. Sex and Age Patterns of Participation in Economic Activities (United Nations publication, Sales No. 61.XIII.4). On the significance of functions of such tables and their variations in time, see Seymour L. Wolfbein and A.J. Jaffe, "Demographic factors in labour force growth", American Sociological Review (Menasha, Wis.), August 1946.

11/ In the Malayan census, as in many others, the classifications of the labour force give no subdivision of the age group of sixty-five years and over, but activity rates for age groups at least up to seventy-five years are needed for satisfactory calculations of the tables of economically active life. Some kind of extrapolation therefore has to be used for estimating rates in age groups over sixty-five. Saw made the extrapolation of the Malayan rates with the help of data from the census of Singapore, which were given in five-year age groups up to seventy-five years.

intervals. For example, the activity rate for the exact age of fifteen years is estimated as the average of the rates for ten to fifteen and fifteen to twenty, and so forth. ^{12/}

Next, the life-table survival function, life-table stationary population, and expectation of life are inserted in the table (columns 4, 6, 8, and 10). ^{13/} In the present example, these are taken from Saw's abridged life-table for the male population of Malaya as of 1956-1958. The survival function (column 4) is the l_x function of the life table, representing the number of survivors that would remain alive at each exact age out of the hypothetical cohort of 10,000 persons subject to the given age-specific mortality rates. The stationary population in each age interval (column 6) is the ${}_5L_x$ function of the life table, representing the number of persons who would be alive within each age interval in a hypothetical population replenished annually by a constant number of 10,000 births and subject to the given age-specific rates of mortality. The stationary population above each given age (column 8) is the T_x function of the life table, derived by cumulating the ${}_5L_x$ values from each given age to the end of life; this represents the aggregate of years of life remaining for members of the hypothetical cohort having survived to each given age. The total expectation of life at each age (column 10) is the e_x function of the life table derived by dividing the cumulated stationary population (T_x) by the number of survivors at each age (l_x). This represents the average number of years of life remaining for survivors at each age.

The numbers of economically active survivors at various ages and economically active persons in the stationary population are obtained by multiplying the life-table values by the corresponding specific activity rates; thus, on each line of the table, column 5 is the product of columns 4 and 3, and column 7 the product of columns 6 and 2. The cumulated economically active stationary population (column 9) is derived by summing the values of column 7 from each age to the end of life.

^{12/} Various other interpolation formulae may be used, or the interpolation may be made graphically with a free-hand curve. The values obtained by any interpolation of five-year group rates for the youngest ages are dubious. Saw did not attempt the interpolation below the age of thirty-five years (it has been carried out by his method for the younger ages in order to complete the present methodological example). Better results can be obtained if the census data are classified in finer age groups below twenty years.

^{13/} On methods of deriving life-table functions and their interpretation, see Barclay *op. cit.*, chap. 4; Roland Pressat, *L'analyse Démographique, Méthodes - résultats - applications* (Paris, Institut national d'études démographiques, 1961), Part II, chap. 3; Spiegleman, *op. cit.*, chap. 5; United States Bureau of the Census, A.J. Jaffe, *Handbook of Statistical Methods for Demographers* (Washington, 1951), preliminary edition, chap. II.

1. Measures of the length of active life

Two measures of average length of economically active life are provided by the table, as shown in columns 11 and 13. The first (column 11) is that of expectation of active life, that is to say, the average number of economically active years to be lived per person in the hypothetical cohort at birth and among the survivors at each age. This is derived by a calculation analogous to that of the total expectation of life, the cumulated economically active stationary population (column 9) being divided by l_x , the total number of survivors at each age (column 4). The expectation of inactive life (column 12) at birth and at each age is then obtained by subtracting the expectation of active life from the total expectation of life. In the present example, out of the total expectation of life at birth of 55.7 years for males in Malaya, 37.3 years would be expected to be spent in economic activity and 18.4 years in an inactive state. The corresponding figures for survivors to the age of 10 are 53.9 total years of life, 42.9 active years and 11.0 inactive years. ^{14/}

The second measure of length of economically active life is that of average remaining years of active life per economically active person among the survivors of the cohort at each age (column 13). For ages above the point at which the specific activity rates reach their maximum (thirty-five years in the present example), the calculation of this measure is analogous to that of expectation of active life, except that the cumulated economically active stationary population (column 9) is divided by the number of economically active survivors (column 5) instead of the total number of survivors at each age (column 4). At ages below the point of the maximal activity rate, a modification of the method has to be introduced, as illustrated in table 4. Without this modification, the values of average remaining years of active life for the younger ages would be exaggerated, since the numbers of economically active survivors at the younger ages would not include persons expected to enter into economic activities later in life, while the active years of the latter would be included in the cumulated economically active stationary population figures. In order to get around this difficulty, the activity rates for the younger ages are replaced by "hypothetical activity rates" equal at each age to the maximal rate, as shown in column 2 of table 4. The economically active survivors at each age, economically active stationary population in each age-interval, and cumulated economically active stationary population above each age are then recalculated as illustrated in table 4, yielding the values of average remaining active years which are shown in column 8 of table 4 and column 13 of table 3. For instance, in this example, the average remaining years of active life for males who are active at age ten comes to 50.5 years, whereas the expectation of active life for all males at age ten is 42.9 years.

Calculations of the expectations of active and inactive life and related functions in table 3 (columns 2-12) can be made equally well with reference to the population of either sex in any country, area, ethnic group etc. for which the required activity rates and life-table functions are available. Of course

^{14/} If measures of average annual time worked per economically active person are available, by sex and age, they can be used for reducing the expectation of active life to the expectation of working time (in hours, equivalent years of full-time work and so on). For example, see Pallós and Valkovics, op cit.

Table 4

Calculation of average remaining years of active life for economically active survivors at ages under thirty-five years, male population of Malaya, 1957

Age interval (exact ages, x to x+5)	Hypothetical activity rate	Survivors at age x of 10,000 born alive		Stationary population in age interval		Cumulated economically active stationary population in ages x-∞	Average remaining active years per active survivor at age x (7.4)
		Total (l_x)	Economically active ($3x2$)	Total ($5L_x$)	Economically active ($5x2$)		
1	2	3	4	5	6	7	8
10-15	97.8	8 698	8 507	43 265	42 313	429 526	50.5
15-20	97.8	8 608	8 419	42 815	41 873	387 213	46.0
20-25	97.8	8 518	8 331	42 295	41 365	345 340	41.5
25-30	97.8	8 400	8 215	41 655	40 739	303 975	37.0
30-35	97.8	8 262	8 080	40 878	39 979	263 236	32.6
35-∞						223 257 ^{a/}	

Source: Swee-Hock Saw, *op. cit.*, adapted.

^{a/} See table 3, column 9.

the validity of results depends on the accuracy of the data on economic activities and of the mortality data on which the life table is based. On the other hand, the validity of measures of average remaining years of active life for economically active persons (column 13 of table 3) depends on certain conditions which do not have to be satisfied for valid measures of the expectation of active life. These conditions are:

(a) That all persons who enter the labour force at any time in their lives do so prior to the age at which the activity rate reaches its maximum, and no survivors retire into inactive status prior to that age;

(b) That the ages at which individuals retire are independent of the ages at which they enter the labour force;

(c) That the rate of mortality at each age is the same for economically active and inactive persons.

Of course, none of these conditions can be expected to be perfectly satisfied in any case, but near satisfaction of them is necessary if the measures of average remaining years of active life are to be accepted as valid within tolerable margins of error. Clearly, the first condition is far from being satisfied in the female population of most countries, and therefore the method illustrated here will not in most cases yield satisfactory measures of average remaining years of active life of economically active females. Additional data on the frequencies of first entry, retirement, and re-entry of females into the labour force at various ages are generally needed for satisfactory measures, and such data are not generally available for developing countries. ^{15/}

The second condition stated above may not be very well satisfied in either the male or the female population of many countries. It is commonly found that males enter the labour force earlier and retire later in life, on the average, in rural areas than they do in urban areas of the same country. Where such urban-rural differences are pronounced and where neither the urban nor the rural population forms an overwhelming majority of the total, the measures of average remaining active years may be rather far off the mark at some ages. In particular, the measures for males in the labour force at the youngest ages would tend to be understated. A like bias is to be expected where correlated differences exist between average ages of labour force entrance and retirement in socio-economic or ethnic groups of the population.

The third condition, of equal mortality rates in the economically active and the inactive population at each age, is likely to be rather poorly satisfied in most cases, but the error on this account would be important only in countries and age groups where mortality rates are high. It seems likely that in most circumstances, mortality rates of persons in the labour force would be lower than those of inactive persons at the same age, since death is often preceded by

^{15/} For an example of the use of such supplementary data in calculating average remaining years of active life of females in the labour force and other functions of tables of working life for females, see Garfinkle, Tables of Working Life for Women, 1950, op. cit. and Work-Life Expectancy and Training Needs of Women, op. cit.

illness which forces retirement from economic activity. If so, the measures of average remaining active years for persons in the labour force would tend to be somewhat understated.

With these considerations in view, the analyst should be cautious in applying the methods described above for calculation of average remaining years of active life of active persons, and cautious in interpreting the results if he decides that they may usefully be included in the table of economically active life.

Some applications of calculations relating to the length of active life in the study of the economic implications of population changes may be noted briefly. Given data on average annual earnings of economically active persons by sex and age groups, one can convert the "stationary active population" figures in columns 7 and 9 of table 3 into amounts of earnings in each age interval and aggregates of the earning potential from each age to the end of active life; the aggregates can then be divided by the number of survivors of the hypothetical cohort at each age to obtain the expectation of earnings per person at each age. Likewise, given estimates of the annual value of consumption per person according to sex and age, aggregates and expected values of consumption can be computed. ^{16/} The results can be used for studying such questions as the effect of a change in age structure of the population or in age-specific activity rates upon the earnings and consumption functions, the losses of potential earnings and consumption resulting from mortality at various ages, the value of investments embodied in human capital, in terms of consumption by young people in the ages before they enter into economic activities (including costs of education) and relationships between these investments and expectations of earnings.

2. Loss of active years by mortality

It is interesting to estimate the reduction of the average length of active life as a result of death prior to the completion of the potentially active years. This is done by comparing the expectation of economically active life with gross years of active life, a measure derived from the age-specific activity rates alone, which shows what the average number of active years per person would be if there were no loss by premature mortality. The method of calculating gross years of active life is illustrated in table 5 with data from the 1961 census of Indonesia. Multiplying the specific activity rates for various age groups by the numbers of years in the groups and summing the products over the range of ten to seventy-five years, one obtains totals of 54.27 years for the gross years of active life of males and 20.77 for females in this age range, out of a potential maximum of sixty-five years if all persons were economically active from the age of ten to seventy-five. Some uncertainty is involved in continuing the calculation beyond the age of seventy-five because the age group of seventy-five

^{16/} For examples, see László Lengyel and Emil Valkovics, "Mennyit termel és fogyaszt az élete folyamán?" (How much is produced and consumed by a man?) Statisztikai Szemle (Budapest), 1965; Egon Szabady, "Basic economic life tables of Hungary's population", paper presented at the Annual Meeting of the Population Association of America, Cincinnati, 1967.

Table 5

Calculation of gross years of active life in ages of ten years and over and ten to seventy-five years, Indonesia, 1961

Age interval (exact ages)	Number of years in age interval	Males		Females	
		Specific activity rate	Average number of active years in age interval (3x2)	Specific activity rate	Average number of active years in age interval (5x2)
1	2	3	4	5	6
0-10	10	0 ^{a/}	0	*0	0
10-15	5	22.6	1.13	15.6	0.78
15-20	5	66.7	3.34	30.6	1.53
20-25	5	87.2	4.36	27.4	1.37
25-35	10	94.4	9.44	27.2	2.72
35-45	10	96.8	9.68	33.3	3.33
45-55	10	95.6	9.56	39.8	3.98
55-65	10	89.6	8.96	39.1	3.91
65-75	10	78.0	7.80	31.5	3.15
75 +	15	61.7	9.26	20.3	3.04
Total, 10-75	65		54.27		20.77
Total, 10-∞	80		63.53		23.81

a/ The Indonesian census data on economic activities are limited to the age group ten years and over. No doubt some children under ten years of age were economically active; thus the use of a zero activity rate for this age group makes for a slight understatement of gross years of active life for the synthetic cohorts at birth.

years and over is not subdivided in the Indonesian census classification. The choice of a number of years to represent the maximum length of active life in this age group is arbitrary; this number has been put at fifteen years for the purpose of the present calculation, on the assumption that no significant number of persons would continue in economic activity after the age of ninety. On this basis, the measure of gross years of active life over the whole range of ages from ten years upward comes to 63.53 for Indonesian males and 23.81 for females out of a potential maximum of eighty years.

The difference between gross years of active life and expectation of active life (or "net years of active life", as the latter measure is sometimes called when such comparisons are made) represents the loss by mortality. Although this may be calculated with reference to any age, the main interest is in effects of mortality on the expectation of active life at birth and at the beginning age of entries into the labour force. The calculation is illustrated below with the data for the male population of Malaya, 1957: 17/

	<u>Active years in all ages 10 and over</u>	<u>Active years in the ages between 10 and 75</u>
1. Gross years of active life . . .	59.2	52.0
2. Expectation of active life at birth	37.3	*36.6
3. Loss of active years by mortality (1-2)	21.9	15.4
4. Expectation of active life at age 10	42.9	*42.1
5. Loss of active years by mortality after age 10 (1-4)	16.3	9.9

*Calculated by subtracting the stationary active population in the age group 75 years and over from the cumulated total for ages 0 and 10 (column 9 of table 3) and dividing the result by the number of survivors in the cohort at age 0 or 10 (column 4 of table 3).

3. Entries into the labour force, retirements, losses by death and related measures

Table 6 illustrates the derivation of the components of change in number of economically active survivors during each age interval, which are shown in the table of economically active life (columns 14, 15, 17 and 19 of table 3). The survival functions and stationary population figures (columns 2-5 of table 6) are transcribed for convenience from table 3. Column 6 shows the increase or decrease

17/ The measures of gross and net years of active life in the age-range of fifteen to sixty-nine years are given for many countries in Demographic Aspects of Manpower. Sex and Age Patterns of Participation in Economic Activities (United Nations publication, Sales No.: 61.XIII.4), table A-7 and pp.18-19.

Table 6

Calculation of components of change in numbers of economically active survivors during five-year age intervals, table of economically active life, male population of Malaya, 1957

Age interval (exact ages, x to x+5)	Survivors at age x of 10,000 born alive		Stationary population in age interval		Increase (+) or decrease (-) of economically active survivors during age interval	Deaths of economically active persons during age interval			Net entries into economic activity (+) or net retirements (-) during age interval		
	Total (l_x)	Economically active	Total (${}_5L_x$)	Economically active		Mortality rate ($1000 \frac{m}{5x}$)	First estimate of deaths ($7x5$)	Adjusted estimate of deaths	Net entry or retirement rate	First estimate of net entries or retirements ($10x4$)	Adjusted estimate of net entries or retirements
1	2	3	4	5	6	7	8	9	10	11	12
10-15	8 698	0	43 265	4 179	+ 2 996	2.08	9	9	+ 34.8	+ 3 011	+ 3 005
15-20	8 608	2 996	42 815	25 685	+ 3 503	2.10	54	54	+ 41.5	+ 3 554	+ 3 557
20-25	8 518	6 499	42 295	39 207	+ 1 489	2.79	109	110	+ 18.8	+ 1 590	+ 1 599
25-30	8 400	7 988	41 655	40 609	+ 84	3.31	134	134	+ 2.6	+ 217	+ 218
30-35	8 262	8 072	40 878	39 987	- 161	4.23	169	169	+ 0.1	+ 8	+ 8
35-40	8 089	7 911	39 872	38 955	- 255	5.74	224	223	- 0.4	- 32	- 32
40-45	7 860	7 656	38 535	37 444	- 351	7.94	297	297	- 0.7	- 54	- 54
45-50	7 554	7 305	36 718	35 319	- 536	11.47	405	404	- 1.8	- 132	- 132
50-55	7 133	6 769	34 240	32 083	- 790	16.65	534	531	- 3.8	- 260	- 259
55-60	6 563	5 979	30 908	27 332	- 1 055	24.69	675	673	- 6.2	- 383	- 382
60-65	5 800	4 924	26 568	21 600	- 1 270	36.62	791	785	- 9.2	- 489	- 485
65-70	4 827	3 654	21 202	14 873	- 1 319	55.32	823	821	- 11.8	- 500	- 498
70-75	3 654	2 335	15 058	8 682	- 1 084	85.34	741	747	- 11.1	- 334	- 337
75-8	2 369	1 251	14 552	6 969	- 1 251	162.80	1 135	531	- 52.8	- 1 537	- 720

in number of economically active survivors during each age interval, derived by taking the differences between the figures for successive ages in column 3. The problem is to estimate two components of the increase or decrease during each age interval: (a) the number of deaths of economically active persons and (b) the net balance between entries of inactive persons into economic activity and retirements of active persons into inactive status. These two components are first estimated independently, and then the estimates are adjusted to force agreement with the increases and decreases shown in column 6.

For the first estimate of deaths of economically active persons (column 8), the life-table mortality rate ($1,000 {}_5m_x$) shown in column 7 is applied to the economically active stationary population in each age interval (column 5), according to the assumption of equal mortality rates for economically active and inactive persons. If the mortality rates of the economically active are lower, as seems likely to be the case in most circumstances, of course this estimate of deaths tends to be exaggerated. The life-table mortality rate used in this calculation represents the number of deaths in the cohort during each age interval (that is, the age-to-age difference in number of survivors, l_x) expressed as a quotient per 1,000 of the stationary population in the age interval (${}_5L_x$).

For the first estimate of the net balance between entries into economic activity and retirements (column 11), a net entry or retirement rate for each age interval (column 10) is applied to the total stationary population in the age interval (column 4). This net entry or retirement rate is obtained by taking differences between the specific activity rates for successive ages (column 3 of table 3). Since this is a five-year rate and it is applied to a five-year age group of the population, the result to be inserted in column 11 must be divided by five. Retirements, it should be noted, include involuntary as well as voluntary withdrawals into inactive status; disability is a major factor, and forced retirement on account of obsolescence of skills, discrimination in favour of employment of younger workers and for similar reasons, may also play an important part.

The adjustment of the first estimates is made on a pro-rata basis, so that the sums (with due regard to sign) of the numbers of deaths and net entries or retirements during each age interval are forced to agree with the corresponding increases and decreases in the number of economically active survivors during the age interval (column 6); and the adjusted estimates are inserted in columns 9 and 12. That the sums of the first estimates fail to agree with the independently determined increases or decreases is due to interaction between the factors of mortality and changing activity rates during the age intervals. The adjustment is minor for all age intervals except over seventy-five years, where both the mortality rate and the retirement rate are very high, so that their interaction becomes very important. Where such a large adjustment is required as is indicated in this example for the ages over seventy-five years, the estimates cannot be regarded as very satisfactory. More satisfactory results would be obtained by carrying out the calculations for five-year age groups up to the age at which the number of economically active survivors becomes negligible (age eighty-five would be far enough in most cases).

In table 3 (columns 16, 18, and 20), the adjusted estimates of deaths, net entries, and net retirements are expressed as age-specific rates, per 1,000 of the economically active stationary population for deaths and net retirements and per 1,000 of the inactive stationary population for net entries into active status.

In the case of males, there is ordinarily no great error in treating the net balances of entries and retirements as estimates of gross entries into economic activity in the younger age intervals and gross retirements in the older intervals. Such an interpretation is not ordinarily warranted in the case of females; additional data are required for estimating gross entries and retirements of females at various ages, in the circumstances existing in most countries.

Taking the net entry and retirement figures for males to represent approximately the gross figures, one can readily derive estimates of the median ages of entry into and retirement from economic activities. From the adjusted estimates in column 12 of table 6, median ages of about 16.5 years for entry and about sixty-six years for retirement of males in Malaya are obtained on the assumption of linear distribution of the figures within each five-year age interval. More precise values of the medians could be obtained if the age classifications were given in greater detail.

One of the principal applications of the results of these calculations is in estimating crude rates (for all age groups taken together) of replenishment of the labour force by entries and its depletion by deaths and retirements. These crude rates are derived by applying the age-specific rates from the table of economically active life to the figures for corresponding age groups in the actual labour force and inactive population of the country concerned, and summing up the results for all ages, as illustrated in table 7 with reference to the male population of Malaya. ^{18/} From the totals at the foot of the table, the following rates are obtained:

	<u>Annual crude rate per 1,000 of the labour force</u>
Entries	37.2
Retirements	4.2
Losses by death	9.9

The difference between the rate of entries and the sum of the rates of retirements and losses by death is known as the labour force replacement rate. In this example, it amounts to an annual increase of 23.1 per 1,000 of the male labour force. It is equally possible to calculate the replacement rate for the female labour force and the total for the two sexes, although valid separate estimates of the entry and retirement rates may not be feasible in the case of females; the net balance of female entries and retirements is then expressed as a rate per 1,000 of the female labour force, and the female replacement rate is obtained by subtracting the rate of losses by death. The replacement rate can be

^{18/} Such crude rates calculated within the context of the table of economically active life would have little meaning, since this table relates to the hypothetical, stationary population of the life-table, in which the labour force is stationary as well; in other words, entries must be balanced by retirements and deaths of economically active persons.

Table 7

Calculation of annual losses from labour force by death and retirement and gains by entries from the inactive population, male population of Malaya, 1957

Age (years)	Population (thousands)	Labour force (thousands)	Inactive population (thousands)	Annual losses from labour force by death		Annual entries into labour force		Annual retirements from labour force	
				Rate per 1,000 of labour force	Estimated number (thousands) (3x5)	Rate per 1,000 of inactive population	Estimated number (thousands) (4x7)	Rate per 1,000 of labour force	Estimated number (thousands) (3x9)
1	2	3	4	5	6	7	8	9	10
10-14	353.3	34.1	319.2	2.2	0.1	76.9	24.5	-	-
15-19	307.3	184.3	123.0	2.1	0.4	207.6	25.5	-	-
20-24	257.6	238.8	18.8	2.8	0.7	517.8	9.7	-	-
25-29	216.0	210.6	5.4	3.3	0.7	208.4	1.1	-	-
30-34	187.5	183.4	4.1	4.2	0.8	9.0	0.0	-	-
35-39	173.5	169.5	4.0	5.7	1.0	-	-	0.8	0.1
40-44	157.0	152.6	4.4	7.9	1.2	-	-	1.4	0.2
45-49	152.5	146.7	5.8	11.4	1.7	-	-	3.7	0.5
50-54	129.3	121.2	8.1	16.6	2.0	-	-	8.1	1.0
55-59	98.7	87.2	11.5	24.6	2.1	-	-	14.0	1.2
60-64	64.5	52.4	12.1	36.3	1.9	-	-	22.5	1.2
65-69	41.2	28.8 ^{b/}	12.4	55.2	1.6	-	-	33.5	1.0
70-74	24.6	14.2 ^{b/}	10.4	86.0	1.2	-	-	38.8	0.6
75 and over	22.6	10.8 ^{b/}	11.8	76.2	0.8	-	-	103.3	1.1
Total, 10 and over	2 185.6 ^{a/}	1 634.6	551.0		16.2		60.8		6.9

a/ Excluding the category of unknown age.

b/ Adjusted on a pro rata basis to add to given total for ages 65+.

interpreted as a sort of rate of natural increase of the labour force, i.e., the rate at which it would grow under conditions of constant age-specific activity rates with the existing population age-structure and the rates of mortality represented by the life-table. It serves as an index of potential growth of the labour force which can be derived from the data of a single census together with an appropriate life-table. Further information on the dynamics of the labour force can be obtained by comparing the data of successive censuses, if they are available; relevant methods will be discussed in the next section.

The labour force replacement ratio is defined as the annual number of entries into the labour force per 100 of the sum of retirements and losses by death. Using the example of table 7, this measure is calculated as follows:

$$\text{Replacement ratio} = \frac{60.8}{6.9 + 16.2} \times 100 = 263$$

The labour force replacement ratio may be interpreted as an index of the pressure on the labour market represented by the demands of entering workers for jobs, in proportion to the number of jobs being vacated by retirement and death.

E. Intercensal comparisons of cohort activity rates

The statistics of the labour force obtained in a census present a cross-sectional view of the working-life histories of many different cohorts, born at different times in the past, whose survivors are found in different age groups at the census date. In a table of economically active life, the age-specific activity rates derived from such a census cross-section are taken to represent the life-cycle of economic activity in a hypothetical cohort. Such an interpretation would be strictly valid only where the age-specific rates remained constant in time so that all cohorts would pass through the same cycle of activity rates in the course of their lives. Where the life-cycles of these rates vary in successive cohorts (as they may be expected to do at least to some extent in any country), producing time-trends in the specific rates for certain sex-age groups, the cross-section of activity rates at any date reflects these trends as well as the age-to-age changes of cohort rates. The result is some bias in the net rates of entry into and retirement from the labour force during various age intervals shown by the cross-sectional table of economically active life, and a related bias in the measures of length of active life (though this latter bias may not be so strong). Where the secular trends of age-specific activity rates are generally upward (as they have been in the female population of certain countries), cross-sectional measures of net rates of entry into the labour force during various age intervals tend to be understated while net rates of retirement during other age intervals are overstated. The directions of bias are opposite where the trends of age-specific rates are downward, as they have been in the case of males under twenty and over fifty-five years in many countries.

Given long historical series of census statistics on population and labour force by sex and age groups, it might be possible to calculate tables of economically active life with reference to the actual working-life histories of real cohorts traced in the tabulations of the successive censuses. For example, in a series of decennial census statistics over the period 1910 to 1960, the cohort of ten to fourteen years of age in 1910 would be identified with the age group twenty to twenty-four years in 1920, thirty to thirty-four years in 1930,

and so on up to the age of sixty to sixty-four years in the 1960 census. ^{19/} Tables of economically active life on this basis are not known to have been constructed with the statistics of any country. Even where such long historical series of census data are available with the required age classifications, the limited possibilities of historical comparison would present obstacles to their use for this purpose.

On the other hand, it is feasible and useful to make less ambitious studies of cohort activity rates where data are available in comparable form for even as few as two census dates. Table 8 shows an example of this, using the data of the 1950 and 1960 censuses of Panama. The 1960 age-specific activity rates for each sex are inscribed diagonally in the table, those for the age group ten to fourteen years in 1960 referring to the cohorts born during 1945-1950, for age group fifteen to nineteen to those born during 1940-1945 and so on. Likewise the rates from the 1950 census are inscribed, age group ten to fourteen referring to the cohorts born during 1935-1940, and so forth. Next, 1955 activity rates are estimated by linear interpolation for each age group, across the horizontal lines of the table. ^{20/} The figures read vertically down the columns then represent segments of activity-rate life cycles of different cohorts so far as they come within the range of the 1950, 1955, and 1960 cross-sections. If and when the Panamanian census is repeated with comparable classifications in 1970, it will be possible to add two more five-year age intervals to the record of each cohort's working-life cycle, and a more comprehensive picture of the shifting patterns of age-to-age changes in activity rates of successive cohorts will be revealed. ^{21/}

Net rates of entry into or retirement from the labour force between successive age levels are derived from the data for real cohorts in table 8 by the same method used to derive such net rates for hypothetical cohorts from

^{19/} "Generation life tables", constructed in a similar way to represent the mortality and survival experience of real cohorts traced over long periods, would be used in calculating such tables of economically active life.. On the construction of generation life tables, see George Barclay, Techniques of Population Analysis op. cit.; Roland Pressat L'analyse démographique. Méthodes - Résultats - Applications, op. cit.; and Mortimer Spiegelman, Introduction to Demography, op. cit. On the methodology of cohort analysis, see Roland Pressat, Principes d'analyse. cours d'analyse démographique de l'I.D.U.P. (Paris, Institut national d'études démographiques, 1961), chap.III.

^{20/} This interpolation of rates for 1955 improves the coherence of the analysis by making the intervals between the cross-sections in time agree with the five-year groups of the age classification. If the interval between the two censuses were, say, seven years instead of ten, the procedure would be to reduce this to five years by interpolation. A possible alternative in such a case might be to regroup the age classification in the earlier or the later census so as to obtain a seven-year interval of ages, but this kind of regrouping is likely to present difficulties.

^{21/} For an example of such an analysis of cohort activity rates over a long period, see John D. Durand, The Labor Force in the United States, 1890-1960 (New York, Social Science Research Council, 1948), chap. 5.

Table 8

Sex-age specific activity rates of population cohorts,
Panama, 1950, 1960 and 1955 interpolations

		Years of birth of cohorts															
		1945- 1950	1940- 1945	1935- 1940	1930- 1935	1925- 1930	1920- 1925	1915- 1920	1910- 1915	1905- 1910	1900- 1905	1895- 1900	1890- 1895	1885- 1890	1880- 1885	1875- 1880	1875 and before
Males																	
1950																	
1955																	
1960																	
Age (years)	10-14	14.3	15.8	17.4													
	15-19		63.2	65.8	68.3												
	20-24			92.3	93.6	94.8											
	25-29				96.5	97.1	97.7										
	30-34					97.0	97.4	97.9									
	35-39						97.1	97.6	98.1								
	40-44							97.1	97.8	98.4							
	45-49								96.4	97.1	97.8						
	50-54									95.0	95.6	96.3					
	55-59										92.4	92.9	93.4				
	60-64											81.8	83.5	85.2			
	65-69												68.9	73.1	77.3		
	70-74													57.8	64.8	71.9	
	75 and over														43.8	50.8	57.7

Table 8 (continued)

		Years of birth of cohorts															
		1945- 1950	1940- 1945	1935- 1940	1930- 1935	1925- 1930	1920- 1925	1915- 1920	1910- 1915	1905- 1910	1900- 1905	1895- 1900	1890- 1895	1885- 1890	1880- 1885	1875- 1880	1875 and before
Females																	
<u>1950</u>																	
<u>1955</u>																	
Age	<u>1960</u>																
(years)																	
10-14		3.8	4.6	5.3													
15-19			23.5	23.4	23.4												
20-24				31.2	30.4	29.6											
25-29					28.3	26.8	25.3										
30-34						27.7	26.4	25.1									
35-39							27.1	26.1	25.1								
40-44								27.0	25.5	24.0							
45-49									26.1	24.0	21.9						
50-54										21.8	20.6	19.5					
55-59											17.4	17.0	16.6				
60-64												12.9	13.0	13.0			
65-69													9.6	10.6	11.5		
70-74														6.7	7.4	8.1	
75 and over															3.5	4.2	4.9

cross-sectional data (as was done with the Malayan statistics in table 6, column 10). It is instructive to compare the results obtained for real and hypothetical cohorts, as is done with the Panamanian data in table 9. While the patterns are fairly similar on the whole, some significant differences appear, illustrating the kinds of biases to which estimates for hypothetical cohorts may be subject. For example, in the case of males, the rates for hypothetical cohorts derived from both the 1950 and 1960 census cross-sections imply net entries into the labour force continuing up to approximately age forty, whereas the estimates for real cohorts make it appear that the dividing line between the ages of net entry and net retirement of males should be placed about ten years lower, near age thirty. In regard to females, while the data for hypothetical cohorts indicate net excesses of retirements over entries in all age intervals beyond the early twenties, those for real cohorts reveal a phase of entries somewhat exceeding retirements at ages between the middle twenties and the middle forties.

Such intercensal comparisons of activity rates of real cohorts are useful for several kinds of purposes. Where the census data are satisfactory in quality and for comparative purposes, they provide more accurate measures of net rates of entry into and retirement from the labour force, and of labour force replacement rates and ratios, than can be obtained from the cross-sectional analysis of data of a single census. ^{22/} They can be used to advantage in studying influences of demographic, economic, and social factors upon labour force dimensions and trends by the methods to be considered in the next chapter; and in some circumstances, they may provide a better basis for projections of future labour force trends than cross-sectional data alone would afford. ^{23/} It is important, however, to recognize some sources of possible error in such measures. Their validity depends, again, on the familiar assumption of mortality rates at each age being the same (or at least not too different) for economically active and inactive persons. They may also be affected by immigration and emigration between the dates of the censuses if the activity rates of migrants are very different from those of non-migrants (although the effect of this factor is likely to be important only where migration occurs on a very large scale). More important, the results may be falsified by differences between the labour force definitions applied in successive censuses and by differences in the nature and magnitude of errors and biases in reporting of economic activities. Errors in the census reporting of ages, and under-enumeration or over-enumeration of the population in certain age groups, may also affect these estimates if the age-reporting and enumeration errors are not the same in the economically active and inactive segments of the population. One of the analyst's means of testing the quality and consistency of his data is to compare the cohort activity rates derived from successive censuses and look for erratic patterns.

^{22/} For examples, see A.J. Jaffe and R.O. Carleton, Occupational Mobility in the United States, 1930-1960 (New York, 1954); A.J. Jaffe and J.N. Froomkin, "Economic development and jobs - a comparison of Japan and Panama, 1950 to 1960", paper presented at Symposium No. 1 on Population Problems in the Pacific, Eleventh Pacific Science Congress, Tokyo, 1966; A.J. Jaffe, "Economic development and the growth of the male labor force of Panama, 1950-1960", American Journal of Economics and Sociology (Lancaster, Pa.), July 1966.

^{23/} For an example of labour force projections in terms of cohorts, see Durand, op. cit., appendix C.

Table 9

Net rates of entrance into (+) or retirement from (-) the labour force
in successive age intervals, hypothetical and real cohorts, Panama,
1950-1960

Age intervals (years)	Males				Females			
	Hypothetical cohorts		Real cohorts		Hypothetical cohorts		Real cohorts	
	1950	1960	1950- 1955	1955- 1960	1950	1960	1950- 1955	1955- 1960
Birth to 10-14	+17.4	+14.3	...	...	+ 5.3	+ 3.8	...	...
10-14 to 15-19	+50.9	+48.9	+48.4	+47.4	+18.1	+19.7	+18.1	+18.9
15-19 to 20-24	+26.5	+29.1	+25.3	+26.5	+ 5.8	+ 7.7	+ 7.0	+ 7.8
20-24 to 25-29	+ 2.9	+ 4.2	+ 2.3	+ 2.9	- 4.3	- 2.9	- 2.8	- 2.1
25-29 to 30-34	+ 0.2	+ 0.5	- 0.3	- 0.1	- 0.2	- 0.6	+ 1.1	+ 0.9
30-34 to 35-39	+ 0.2	+ 0.1	- 0.3	- 0.3	0.0	- 0.6	+ 1.0	+ 0.7
35-39 to 40-44	+ 0.3	0.0	- 0.3	- 0.5	- 1.1	- 0.1	+ 0.4	+ 0.9
40-44 to 45-49	- 0.6	- 0.7	- 1.3	- 1.4	- 2.1	- 0.9	0.0	+ 0.6
45-49 to 50-54	- 1.5	- 1.4	- 2.2	- 2.1	- 2.4	- 4.3	- 1.3	- 2.2
50-54 to 55-59	- 2.9	- 2.6	- 3.4	- 3.2	- 2.9	- 4.4	- 2.5	- 3.2
55-59 to 60-64	- 8.2	-10.6	- 9.9	-11.1	- 3.6	- 4.5	- 3.6	- 4.1
60-64 to 65-69	- 7.9	-12.9	-12.1	-14.6	- 1.5	- 3.3	- 2.4	- 3.4
65-69 to 70-74	- 5.4	-11.1	-12.5	-15.3	- 3.4	- 2.9	- 4.1	- 3.9
70-74 to 75 and over	-14.2	-14.0	...	...	- 3.2	- 3.2	...	...